LPG Bottling Terminal Plant of Orion Group

At MONGLA KHULNA

Submitted by

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Acknowledgement

The project which is very close to my heart and I have dedicated most of my time studying, knowing and understanding how an Industry functions. Thanks to almighty for His graciousness, unlimited kindness and with the blessings of whom the good deeds are fulfilled.
I believe I am very much fortunate because of the guidance I have got throughout the journey and the final success and outcome would not have been possible without these people. Firstly I would like to thank my parents as they have had my back from the beginning. They were the sticks to my stones through these hard times. The next set of appreciations should go to my university teachers who have helped me to complete these 5 years. First and foremost, I would like to thank Ar. Abul Fazal Mahmudun Nobi who has inspired me the most during my student life. Next, I would like to thank my course instructors, Ar. Mohammad Habib Reza, Ph.D, who has pushed me to the limit, Ar. Badru Ahmed, who has given me the craziest ideas and finally Ar. Iftekhar Ahmed without whom this project would not have been possible.

Abstract

Commercial resources of the country are well-developed natural gas sector and undeveloped coal sector. Demand of energy increases at the rate of 7% per annum in the country. To meet this increasing demand of energy a long term strategic plan is under implementation for systematic exploration and proper appraisal both in the offshore and onshore areas in Bangladesh. Bangladesh has good potentialities of hydrocarbon in the offshore and deep sea areas.

In Bangladesh natural gas is one of the most important sources of energy that accounts for 73% of the commercial energy of the country. Till now 23 gas fields have been discovered in the country. As of December 2010 the estimated proven recoverable reserve was 15.32 TCF, total 9.43 TCF gas has been already produced leaving only 5.89 TCF of recoverable category (P1), 5.31 TCF of probable (P2) and 7.01 TCF under possible (P3) category.

Being the one of the largest conglomerate in the field of “Energy & Power” Sector in Bangladesh, Orion Gas Limited (OGL) has a mission to serve the complete rural mass people as well as city population of Bangladesh including export market abroad and to provide the rapidly grown urbanized areas of Bangladesh.

Client Vision

The company has its own 10.0 Acres Industrial Plot with LPG Import Jetty and 3,000 MT bulk LPG Storage Capacity Storage Tanks. This would be a major import based LPG Terminal in Bangladesh. Depending on the variable international oil market condition, bulk LPG would be imported in 2,500 MT parcel LPG Tanker Vessel mainly from some Asian countries like Malaysia, Indonesia, Singapore, UAE, KSA etc.

The LPG Filling Plant would be of European Origin with the latest computer controlled digital technology which would ensure 100% accurate and safe operations. The Plant would be designed, constructed and commissioned as per the latest version international standards.


ASSAM
Kishanganj
Guwahati
Dokmoka
Lanka
NAGA
Dinajpur
দিনাজপুর
MEGHALAYA
Shillong
Birampur
বিরামপুর
Senapati
Sylhet
সিলেট
Silchar
Imphal
Farakka
MANIPUR
Rajshahi
রাজশাহী
Bangladesh
Shaistaganj
শায়েস্তাগঞ্জ
Aizawl
TRIPURA
MIZORAM
Jessore
যশোর
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মাদারীপুর
Chowmuhani
চৌমুহনী
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Kolkata
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Sundarban
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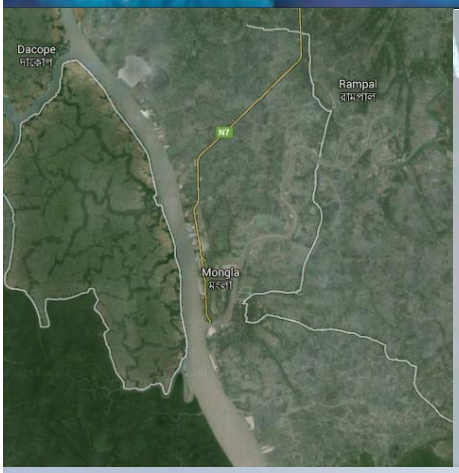
Digha
Cox's Bazar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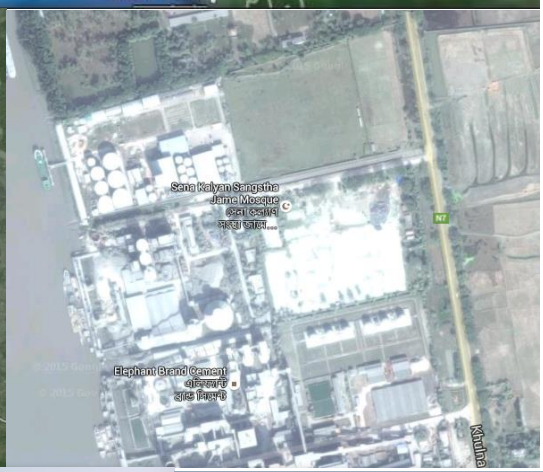
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Elephant Brand Cement

Chapter 01

1.1 Background

The Bangladesh government has proposed to encourage consumption of liquefied petroleum gas (LPG) instead of piped natural gas to ease the mounting gas crisis across the country. Conferring to sources the energy ministry has already asked the LPG firms to increase their import of LPG to meet the gross gap between the demands for, supply of, piped gas, especially in households for cooking and light engineering workshops.
The government decides to encourage LPG use has come at a time when gas crisis turned acute and the urban residents are struggling for cooking due to insufficient gas supplies and drastic fall in gas pressure. Days after days they suffer and are being neglected of their human right.
Officials said the government is also actively considering reduction of duties and taxes on import of LPG and LPG cylinders to boost import and expand its use to ease the mounting gas crisis.

1.2 Objective

The objective of the thesis paper is to rationalize the concept of sustainable Industry architecture and to expose the need of an architect in designing an Industry. The project was chosen on the first place keeping in mind of the functional aspects of technological challenges of an industry and also its view through an eye of an architect. As described later on in this paper the designed industry acts as a prototype to revolutionized Industrial architecture.

1.3 Methodology

Qualitative research is the approach usually associated with the social constructivist paradigm which emphasizes the socially constructed nature of reality. It is about recording, analyzing and attempting to uncover the deeper meaning and significance of human behavior and experience, including contradictory beliefs, behaviors and emotions.

The process:

The approach adopted by qualitative researchers tends to be inductive which means that they develop a theory or look for a pattern of meaning on the basis of the data that they have collected. This involves a move from the specific to the general and is sometimes called a bottom-up approach. However, most research projects also involve a certain degree of deductive reasoning.
For this project the bottom up reasoning was a very important tool as the research was completely based on the interviews taken of the workers on the spot and following examples of previously designed factories around the area.

Mixing of other methods:

Being able to mix different approaches has the advantages of enabling triangulation. Triangulation is a common feature of research methods studies. It involves, for example:

- the use of a variety of data sources (data triangulation)
- the use of several different researchers (investigator triangulation)
- the use of multiple perspectives to interpret the results (theory triangulation)
- the use of multiple methods to study a research problem (methodological triangulation)

1.4: Project rationale:

Liquefied Petroleum Gas plays a small but essential role in answering to the global needs. LPG is produced by a mix of light hydrocarbons, predominantly propane and butane, changing to a liquid state when compressed at moderate pressure or chilled. It is considered to be the cleanest fuel, due to its low NO2 emissions (roughly 80% less than solid fuels), respecting the environment and contributing to save millions of lives worldwide, especially in underdeveloped countries where the population is still using kerosene and wood fire for cooking, causing premature deaths due to air pollution exposure. Globally it is known to be the optimum source of energy. However, if we browse undeveloped countries, the amount of people who are still using solid fuels represent a huge portion of the population. Providing modern energy to the billions of people in poor countries who are still forced to rely on inefficient traditional fuels and kerosene remains a major challenge. Expanding household use of LPG in these countries could make a major contribution to eradicating energy poverty, bringing considerable health, developmental and environmental benefits. LPG may contribute to guaranteeing empowerment and education for children and women.

According to the World Health Organization (WHO), around three billion people cook and heat their homes using open fires and mud stoves burning biomass (wood, animal dung and crop waste), as well as coal. Furthermore, the WHO estimates that around 4.3 million people die each year from diseases attributed to indoor air pollution, including chronic respiratory conditions such as pneumonia, lung cancer and even strokes.

In addition to that, LPG is commonly used also for transport, as its low emissions contribute to reducing air pollution. Indeed, in the UK recently Auto gas has claimed LPG should be re-listed as exempt from congestion zone charging and will save millions of lives, in response to a new research conducted by King's College that revealed 9,400 people die each year in the capital as a result of long-term exposure to air pollution – more than twice as many as previously thought.

Indeed, NO2 emissions from LPG vehicles are up to 80% lower than diesel and particulates are up to 98% lower than diesel.

The motto to design this process would be to not only help the country economically but to see the rural sector of Bangladesh to use the future of fuels as well as promote environmental friendly source of fuel. Right now Bangladesh is going through a big crisis of natural gas. Pipeline natural gas connections to households have been stopped for almost 3 years. Policymakers are saying that in future no pipeline natural gas would be used for cooking purpose. LPG would be one of the viable options for cooking for most of the households.
There are several industries like glass and ceramics, auto bricks etc. where they have to use burners. LPG would be the possible solution where natural gas is not available. For welding purpose use of LPG is increasing very fast.

1.5: Opportunities, Needs, Aims:

There are risks associated with every workplace. In some industries, the outcome of a typical incident may be relatively slight, for example an office worker shaken and upset by slipping on a wet floor. In other industries a typical incident can have far more severe consequences, such as a farmer pinned beneath an overturned tractor, a building worker hurt in a fall, or a factory worker caught up in machinery.
Industrial accidents create not only personal grief and distress but also huge financial costs and unwelcome negative publicity for the organization and industry concerned. They are of great interest and concern to all of the organization's stakeholders eg employees, managers, shareholders, local residents and businesses, and suppliers.
In a modern society, people will not allow organizations to ignore the impact of their activities on surrounding communities. Not all of the stakeholders have the same interests. In meeting their health, safety and environmental responsibilities, businesses have to strike a balance between conflicting interests.

Aims and needs:

- Creating a relaxed working environment for the workers. Ensuring more playful workspace for the workers by rethinking their workplace.

- Incorporating green areas alongside their working areas to increase efficiency and creating a psychological balance.

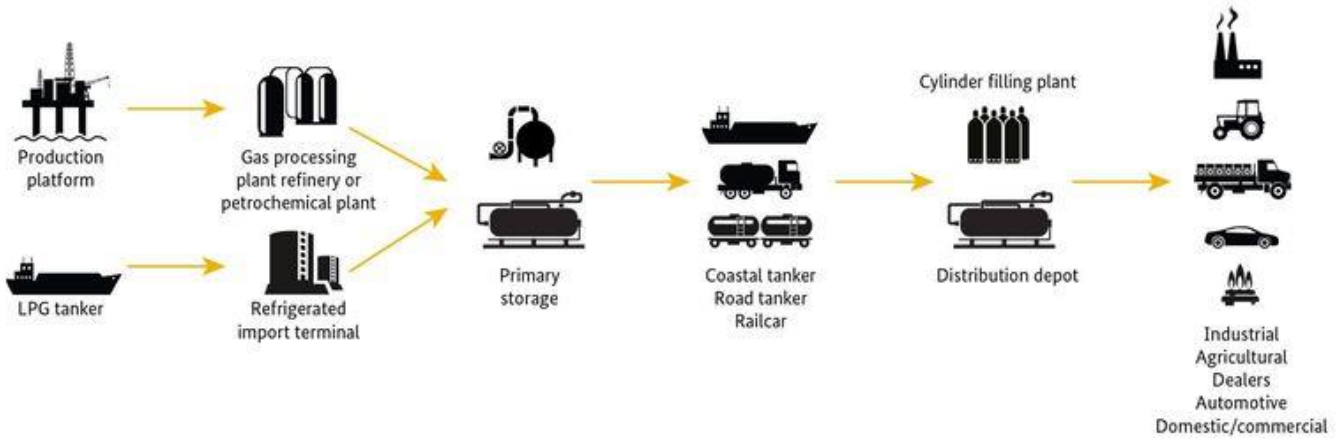
- Environmental-friendly industry by special consideration in terms energy consumption, natural lighting & ventilation, maximum day light usage.

-Introducing the aspects of reuse of scrap metal. This also acts as a breakthrough of industrial material use and reuse.

- Sensible Consideration in choosing construction materials and orientation of the form. Not only the usage of such building materials which contribute to green living but also the adaptation of such construction technique which has a minimal effect on the environment.

-Extreme caution for worker's safety and protection from fire.

1.6 Proposed requirement/program



A. Plant Capacity: 30,000 MT/Year: 30,00,000Cyl. (12.0 Kg)/Single Shift/Year.

a) Bottling Capacity/Month: 3,000 MT/Single Shift
b) Bottling Capacity/Day: 10,000 Cylinders (12.0 Kg)/Single Shift

B. Products: Bottled and Bulk LP Gas in different pack sizes as:

1. Domestic Fuel:

a) Normal Size: 12.0/12.5 Kg/Cylinder,
b) Small Size: 5.0/5.5 Kg/Cylinder,
2. Commercial Fuel:

a) Medium Size: 24.0/25.0 Kg/Cylinder, b) Large Size: 33.0/40.0/50.0 Kg/Cylinder,
3. Bulk Fuel: 8.0/10.0/15.0/20.0 MT LPG in Bulk Tank which would be located at Industrial Clients' premises that may be used as LPG Generator Fuel, Gas Cutting Fuel, at some Orion Authorized Oil Filling Stations for their Mini Filling Unit and at some multi-storied Apartments for colony fuel etc.

4. Portable Mini Filling Station: Specially for Domestic Cylinders, there would have some LPG Road Tanker (Lorry Mounted Bulk LPG) fitted with Filling Machines on board which would stop at some major demanding locations to facilitate from the Clients from their nearest points.

5. Other Products: International Standard Brand Insecticidal Aerosol, Air Freshener, Body Spray, Fragrant etc.

C. Plant Location: Plot No. I-20, Mongla Port Industrial Area, Mongla, Bagerhat.

Administration			
Designation	No. of People	Toilet	Area
CEO/MD	1	A/T	285
COO	1	A/T	190
CFO	1	A/T	180
GM	1	A/T	180
AGM	1	A/T	160
Department	No. of People	Toilet	Area
Accounts			
Head of Accounts	1	DC	150
Accounts Manager	2	DC	150
Accountant	2	S/T	150
Marketing & Merchandising			
Head of Marketing	1		150

Marketing Manager	1		150	
Merchandiser	4		300	
Convention Section				
Conference Room		DC		
Meeting Room		DC	380	
Supply Chain				
Supply Chain Manager	1		150	
Supply Chain Executive	3		220	

LPG Dolphin jetty

Designation	No. Of People	distance	Area	description
Working platform		distance between two dolphins would be 35m.		Outer dolphins will have evacuation ladders. The interconnecting walkways between platform and dolphins will be constrcuted from 36" dia pipe and 1m wide walkway
Bridge approach/ deck platform		6m above tide.(height)		it will have 10 piers (762 mm dia), handrails will be removable. The trestle to be of 5m wide and 3m wide precast road for pickup, pipe way for 8" dia product line, 6" vapour return line and 12" dia fire water line
LPG marine loading/ Unloading		(L x W)= 10m x 8m)		one loading arm with piggy back vapour return line, Access gangway, EFC valves firefighting facilities
Vapour return line		6" dia loading arm		this is to keep the gas inert
LPG Drain tank/ pump				to collect LPG from unloading line and pump into storage
Neceassary supplies (electrical connections/fire and drinking water				
pathways connecting jetty and platforms		140m long		
berthing line		60m from the shore		

LPG drain vessel		1m dia and 2m length		

Security Section

common	No. Of People	Toilets	Area	
Security Head	1		150	
CCTV Controller	1		130	
Fire Surveilance	1		150	
Guards	30			

Fire fighting Security				
jetty surveilance				

LPG BULK STORAGE

Designation	No. Of People	distance	Area	description
above the ground Spherical Storage System		2 horton sphere of 17m dia.		for storage of 3000MT in total
Storage control sytem room				
pipeline		pipeline from jetty to storage of dia 12"		

Loading/Unloading Labor

Shifting materials	10		231sqft	

Utility

Machine	No. Of People	Toilets	Area	
Sub Station	2		517sft	
Generator			602 sft	
Boiler (9tonne)			400sft	
Compressor				
Utility Manger	1		150	
Assistant	2		130	

Dining

3000

Designation	No. Of People	elements	Area	
Chef	2			
Waiter	4			
Cleaner	5			
Kitchen				

wash				

store				

Industrial area

plants	No. Of People	elements	Area	description
Bottling plant			12850sqft	
Filling plant		30 filling scale(12kg) , 2 unit standalone filling machines(20-50kg)	12,000 sqft	This set to be designed to meet the required capacity in future. The machines are: , Roller Conveyor, Automatic Electronic LPg Filling Machine, Automotive Cylinder Weight Check Scale, Electronic gas leak detecting Unit, Automatic Fill Correction Machine, Cylinder valve Cap machine, Cylinder Cap Sealing Machine, Cylinder EvacuationmUnit, Compressor Air System, Hydrauli Control System, LPG Pipe Line Pressure Regulator.
Main switch And control circuit area		1		Power consumption : 180m3/Hr pressure: 7Kg/Cm2
loading/ Unloading bay		4 truck capacity two bays (2m)		The vacant cylinders for refilling would
Visual inspection room		1	200	
Minor maintenance room		1	200	
Evacuation Pump Unit for cylinder		1	250	
Truck weight scaling area		2 surfaces. Empty and filled.		
Solar Desalinization plant				
Maintenance area			1100 sqft	
Maintenance room Cylinder		1	400	
staff room		2	200	
maintenance room machineries		1	500	For maintenance and service of machineries.

Fire fighting infrastructure

Fire detection office	7	2	400 sqft	
pipeline infrastucture				
water storage tanks				
water monitor system				1) strorage tanks 2) Cylinder filling sites 3) road tankers gantries 4) loading unloading gantries

Warehouse

	No. of people	No. of room	Area	description
empty cylinder				
filled cylinder ready for shipping				
Security room				
Accommodation				
Function	No. Of People	Toilets	Area	
Single bed	1	A/T	120sft x 3	
double bed	2	A/T	200 sft x4	
Reception				
Prayer				
Function	No. Of People	No. of room	Area	
Prayer hall	50	1	1500 sqft	
wudu area	15	1	500 sqft	

Fig: The table of area for allocated programs

1.8 Operation detail: -

Buying bulk LPG from foreign refineries or traders
- Shipping the bulk LPG to their terminals in Bangladesh via seagoing gas carriers
- Storing the bulk LPG into spheres or bullets via jetty pipeline
- Finally filling the gases into pressurized cylinders for onward distribution to the final consumers.

Ideally, once the customers use up all the gas, the empty cylinders are sent back to their respective operators for refilling.

Process Details

1.7.1: Bulk unloading system:

The proposed facility will receive LPG through road tankers. The LPG from road tankers is unloaded and stored in two mounded Bullets of 75 MT capacity each. The total storage capacity will be 150 MT in two mounded bullets configuration with one 75 MT bullet for future provision.

The bulk unloading system will be designed for the capacity of 72 MT per shift. The unloading process will start by connecting road tanker liquid line to respective receiving bullet. The liquid LPG flow will continue till the pressure in road tanker and receiving bullet equalizes with each other. At this stage the LPG compressor will be started, with its suction line connected to bullet and the discharge line connected to road tanker vapour line. The vapour pressure difference in bullet and road tanker drives the LPG liquid from road tanker to bullet. The liquid LPG unloading further continues until the complete road tanker is unloaded. The pressurised LPG vapour left in the road tanker will be recovered with the help of compressor by changing the compressor suction from mounted bullet to road tanker through 4 way valve. The recovered vapour will be stored in respective bullets.

1.7.2: Bottle filling System:

12, 17 & 33 Kg capacity Cylinders
The filling station will have the capacity of 60 MT per shift. In the filling station the empty cylinders (12, 17 & 33 Kg) will be fed to the automated chain conveyor system. The conveyor system will be routed through the following units for completing the filling process,

_ Empty cylinder weight scale with CVT _ Cylinder washing unit _ Electronic filling machines (10 nos) _ Online electronic cylinder weight scale unit _ Digital compact valve tester unit(DCVT) _ In line Test bath _ Hot air sealing unit

The filled LPG cylinders will be conveyed and stored in the filled cylinder storage shed.If any cylinders are rejected from the online electronic check scale unit then it will be directedto the manual weight correction unit where the weight correction will be done manually and then it will be routed to the automated conveyor for subsequent process.
If any filled cylinder fails in the DCVT and in line test bath unit, then the defective cylinders will be directed to evacuation rack for evacuation and repairing work. The evacuated LPG from rejected cylinders will be collected in an evacuation vessel and then stored in storage bullets.
The emptied cylinder will be purged using the purging unit.
The liquid LPG will be supplied to the filling heads through LPG vane pumps. The LPG pumps suction and discharge lines will be designed with all safety requirements.

1.7.3: 450 Kg capacity Cylinders:

The 450 Kg empty cylinder will be brought to the filling point and taken back to the loading bay with the help of manual trolley. The 450 Kg cylinders shall be filled in the two numbers, dedicated electronic filling machines.
All filling station equipment shall be designed as per OISD 169 guidelines.

1.7.4: Bulk loading system:

The liquid LPG will be loaded to road tankers from storage bullets at a rate of 144 MT per shift. LPG pumps will be used for loading the road tankers. The loading process will be done simultaneous to LPG bottling. Therefore, standby LPG pumps will also be operated during road tanker loading and bottling process.

1.7.5: Raw Material Requirement

The LPG bottling plant is a refilling station and hence raw material is not required as it is just a storage and filling station would be imported by way of sea through Tutcorin port. Further they would be transported by Road to various domestic, commercial and industrial customers

1.7.6: Water Requirement

Water requirement for the proposed project is 10 KLD and the break up is given in Table 3-3.The required water will be met from KIADB. Table 3-2 Water Requirement for the Project

S.No	Water Requirement	Proposed
1.	Domestic	1
2.	Cylinder washings	2
3.	Fire fighting	4
4.	Green belt	3
5.	Total	10

1.7.7: Power Requirement

Power Requirement for the project will be sourced from BESCOM.

Details	Proposed Capacity	Source
Power Requirement	322KVA	BESCOM
Power Back Up	250 kVA standby 160 kVA	DG Sets

1.7.8: Liquid Waste Management

For the proposed project there is no manufacturing process as it is only storage and filling plant hence there will be no generation of Effluent. Sewage will be treated through septic tanks and soak pits. Effluent from Cylinder washings will be treated using settling tank and the supernatant will be used for green belt.

1.7.9: Fire Fighting System Description

Following are the type of fire protection systems for proposed LPG bottling plant,

-Automatic Fire Water Pumping System consisting of one Main Pump, one Standby Pump & one jockey pump.

-External Hydrant & Water Monitor System covering the entire proposed plant area for manual fire fighting.

-Medium Velocity Water Spray System for Cylinder filling shed, Filled storage shed, Tank truck gantry (Two bays), LPG Pump / Compressor shed, above ground mounded bullet tunnel, dome, manholes, Loading/Unloading shed, Painting Booth cum Cold Repair Shed and Connecting platforms.

-Fire Detection & Alarm System covering the entire proposed plant area.

-Portable Fire Extinguishers.

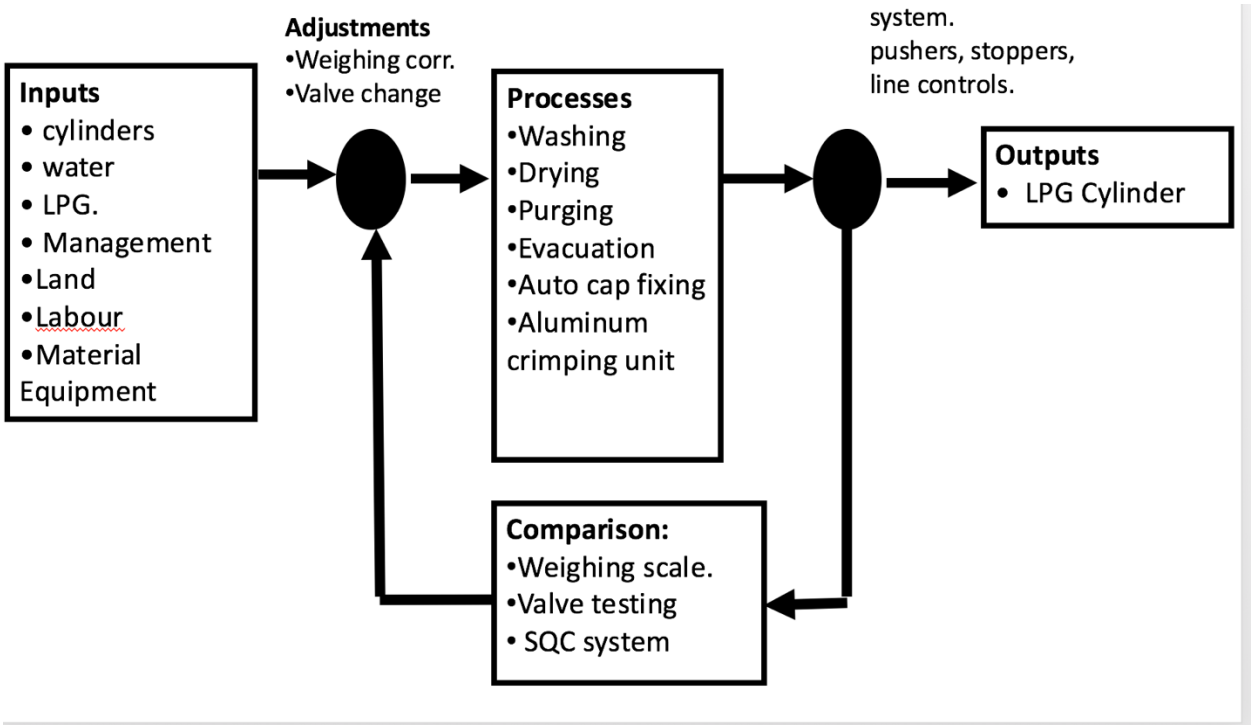
-Personnel Health & Safety Equipment.

1.7.10: Design Basis for Pumps

. Spray density of 10LPM/m2 is considered as per OISD: 169 clause 4.4.2.
. Highest Water Requirement for water spray system is 4000 LPM for cylinder filling shed.

. As per OISD: 169 clause 4.4.2. (iii), the fire water system in the plant shall be designed to meet the highest fire water flow requirement of a single largest risk of any cases at a time plus 72 Cu. M per hour for operating 2 hydrant points.
. 72 Cu. M per hour = 1200 LPM.
. Total Water required = 4000 + 1200 = 5200 LPM (312 m3/hr).
. The next available pump is 6834 LPM (410 m3/hr).

Graphical representation of the process:



The importunate of the online units and its uses :

Drying unit

The Drying unit is an on-line equipment used to dry the cylinders, coming out of washing unit by blowing the air on the sides and top surfaces of the cylinders as they move.

Washing unit

The Washing unit is on-line equipment used to wash the incoming cylinders with multiple forced jet of water to remove mud, dirt, stains, etc., from the outer surfaces.

Purging unit: Purging Unit is an on-line equipment used to create vacuum in the first stage and filling LPG vapor in the second stage in new / hot repaired empty cylinders.

Evacuation system: Evacuation unit is an on-line equipment used to remove LPG liquid and depressurize cylinders identified leaky during post fill valve performance testing.

Weigh correction unit

The unit is an on-line equipment used to ensure that correct weight of LPG fuel is carried in the cylinders.

Under-filled cylinders are filled with additional quantity of LPG and the weight is corrected. Overfilled cylinders are checked and the weight of LPG fuel is corrected by evacuation process.

Degassing system: Degassing unit is an on-line equipment used to remove LPG vapor from a batch of damaged cylinders identified during post fill inspection using water and air.

Pushers stoppers and line controls: Pushers and stoppers are fabricated units with pneumatic cylinders along with proper guides. Smooth transfer of cylinders between the parallel conveyors .

Chapter 2

2.1 Site Analysis

Site analysis is a preliminary phase of architectural and urban design processes dedicated to the study of the climatic, geographical, historical, legal, and infrastructural context of a specific site. The result of this analytic process is a summary, usually a graphical sketch, which sets in relation the relevant environmental information with the morphology of the site in terms of parcel, topography, and built environment. This result is then used as a starting point for the development of environment-related strategies during the design process.

Steps in site analysis:

-Research phase: The first step is defining the problem and its definition. This is part of the research phase. The site design and site planning process begins with the initial problem to be solved. This is started by a client contracting a planner to work with a particular site.
-Analysis phase: The next step involves programming the site as well as site and user analysis, which is focused on in-depth below. There are numerous site elements related to the analysis during this phase. This is part of the analysis phase in site planning.
-Synthesis phase: From the analysis, a program is developed, which is part of the synthesis phase. The third step deals with schematic design of a site plan as well as a preliminary cost estimate for the site. Step four involves more developed designs and a detailed cost estimate. Step five is the construction documents or the plan. Bidding and contracting for the project follows as step six. Construction then will take place as step seven. The final step, step eight, in the site design process is occupation and management of the site.

2.2 The Site

2.2.1 The Background

The Company has its own 10 Acres Industrial Plot with LPG Import Jetty facility and 72,000 MT bulk LPG Storage facility. Bulk LPG would be imported by LPG Tanker Vessels from Malaysia, Indonesia, Singapore, UAE, KSA etc to Mongla port.

2.2.1a About Khulna District

Khulna is an old river port located on the Rupsha River. It is an important hub of Bangladeshi industry and hosts many national companies. It is served by Port of Mongla, the second largest seaport in the country. It is also one of the two principal naval command centres of the Bangladesh Navy.

[h ide]Climate data for Khulna

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	25.6 (78.1)	28.5 (83.3)	33.1 (91.6)	34.6 (94.3)	34.3 (93.7)	32.9 (91.2)	31.8 (89.2)	31.8 (89.2)	32.1 (89.8)	32.1 (89.8)	29.9 (85.8)	26.5 (79.7)	31.1 (88)
Average low °C (°F)	12.4 (54.3)	15.4 (59.7)	20.5 (68.9)	23.9 (75)	25.2 (77.4)	26.1 (79)	26.0 (78.8)	26.2 (79.2)	25.8 (78.4)	24.1 (75.4)	19.6 (67.3)	13.9 (57)	21.6 (70.9)
Average precipitation mm (inches)	13.3 (0.524)	44.4 (1.748)	52.1 (2.051)	87.5 (3.445)	200.0 (7.874)	335.6 (13.213)	329.8 (12.984)	323.5 (12.736)	254.7 (10.028)	129.8 (5.11)	32.1 (1.264)	6.6 (0.26)	1,809.4 (71.236)
Average precipitation days	2	3	3	6	11	14	17	16	13	7	2	1	95
Average relative humidity (%)	78	74	73	76	79	85	87	86	87	84	80	79	81

Khulna is the third largest economic centre in Bangladesh. It is situated north of the Port of Mongla and has various heavy and light industries. The major sectors are jute, chemicals, fish and seafood packaging, food processing, sugar mills, power generation and shipbuilding. The region has an Export Processing Zone which has attracted substantial foreign investment. The city is home to the corporate branch offices of numerous national companies, including among others, M. M. Ispahani Limited, Beximco, James Finlay Bangladesh, Summit Power and the Abul Khair Group. Some of the largest companies based in the city include Khulna Shipyards, Bangladesh Oxygen, Platinum Jubilee Mills, Star Jute Mills and the Khulna Oxygen Company.

Khulna is humid during summer and pleasant in winter. Khulna has an annual average temperature of 26.3 °C (79.3 °F) and monthly means varying between 12.4 °C (54.3 °F) in January and 34.3 °C (93.7 °F) in May. Annual average rainfall of Khulna is 1,809.4 millimetres (71.24 in). Approximately 87% of the annual average rainfall occurs between May and October.

2.2.1b About Mongla port

Mongla Port the second largest seaport, 48 km south of Khulna town. The port was developed initially about 18 km up at Chalna, which was opened to foreign vessels as an anchorage on 11 December 1950. The anchorage was shifted to Mongla in 1954 as the place could accommodate sea-going vessels with greater draughts. The port of Mongla had long retained its name Chalna. Mongla is situated on the confluence of the rivers pasur and Mongla at mouza Selabunia of rampal upazila of bagerhat district. During the Pakistan period, the administration of the port was under a port director, whose main office was at Khulna.

Mongla Port

Sea-going vessels up to a draught of 25 feet could berth vessels here and those with a draught up to 17 feet were allowed to anchor. Although fairly small, Mongla was a busy port in the past and at times, about two dozen sea going vessels were found anchored here. Later, especially since 1980, the port often remained closed because it lost proper depth required for the ocean-going ships and every time it was reopened after dredging. At present, about 400 ships berth at the port in a year and the port annually handles about 3 million MT of imports and exports. The port has 11 jetties, 7 shades for loading and unloading of goods and 8 warehouses. It uses 12 swinging moorings or floating berthing places in deeper sections in the river. The Mongla Port Authority that now administers the port constructed a rest house for the seamen at a place named Heron Point.

The port has trade links with almost all major ports of the world, although vessels arriving here are mostly from ports of Asia, the Middle East, Australia, Europe and North America and the ships rarely come to Mongla from the countries of Latin America or Africa. In addition to promotion of imports and exports of the country, the port contributes to development of many industries and trading houses in surrounding places and along with this, of new infrastructures and job opportunities. Many local people are working in the port directly in loading and unloading vessels. [Syed Md Saleh Uddin]

2.3 Site at a glance

2.3.1 Site location

The site of the proposed Industry is located on a 10 acre land in between an oil refinery factory at west and a cement factory on south. The eastern side of the plot is accessible towards the main road.

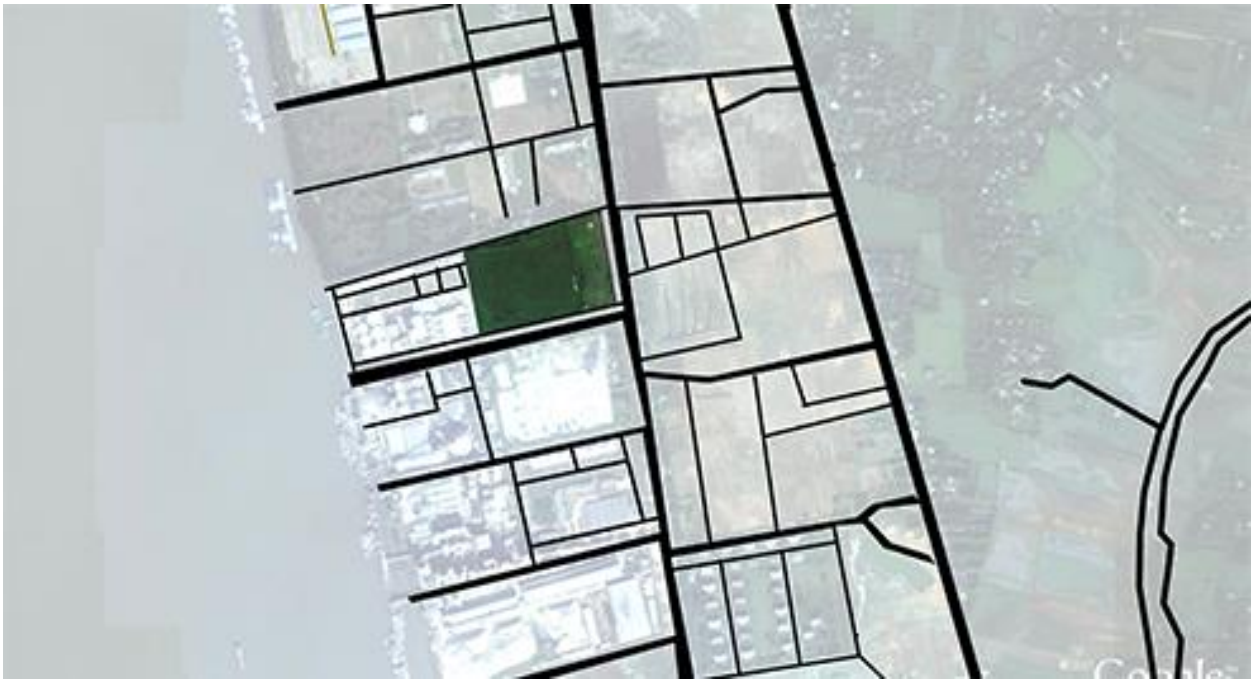
The scenario from the Poshur river towards the site.

2.3.2 Site analysis

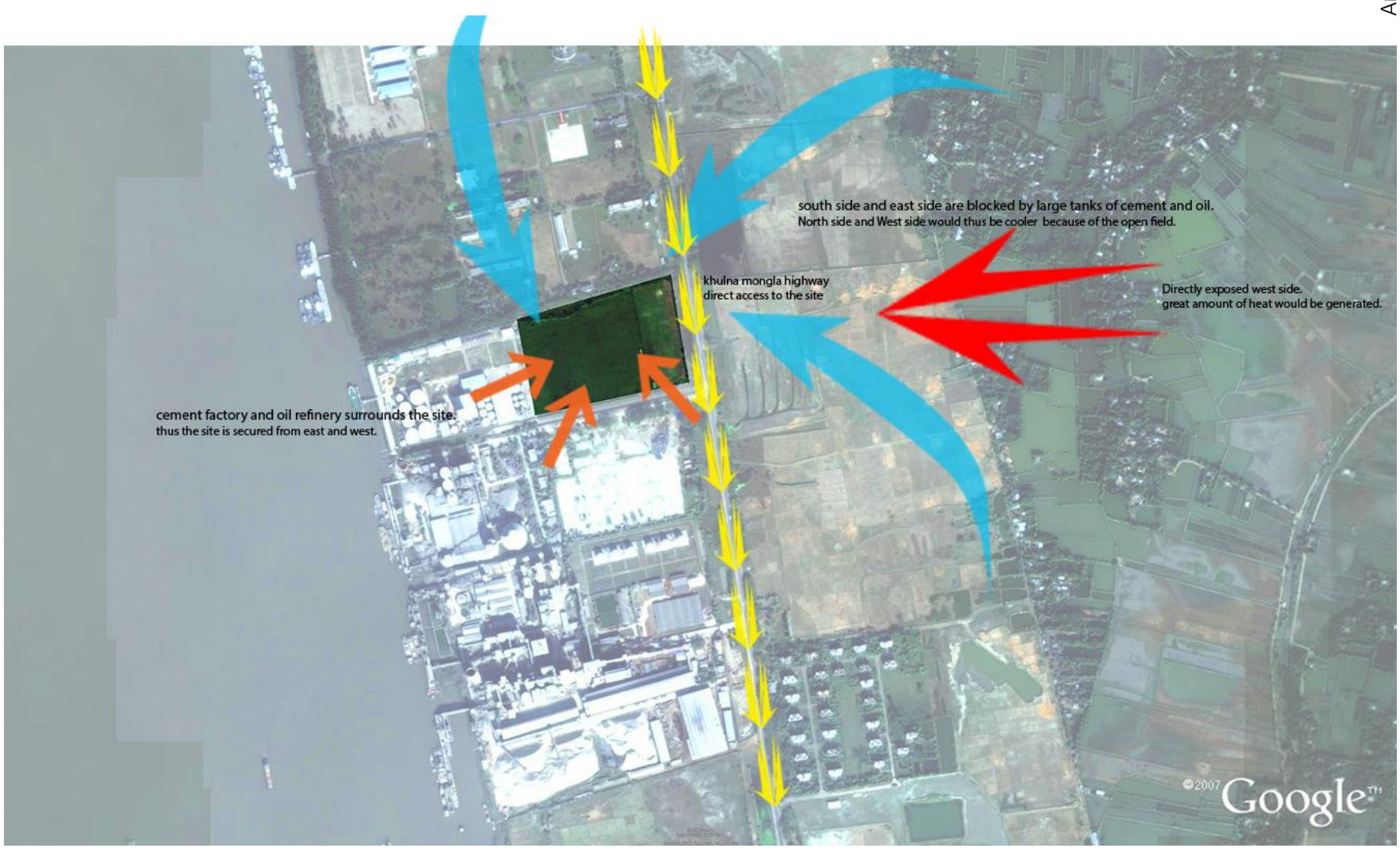
The location of the site

Habitat around the area

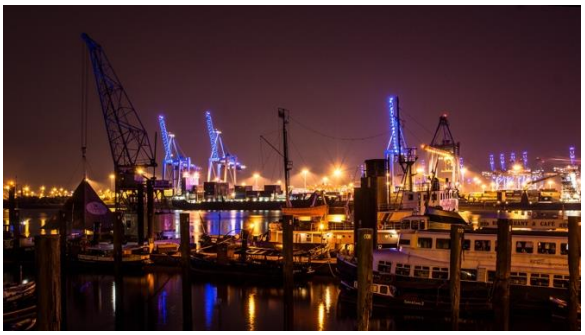
Factories around the plot



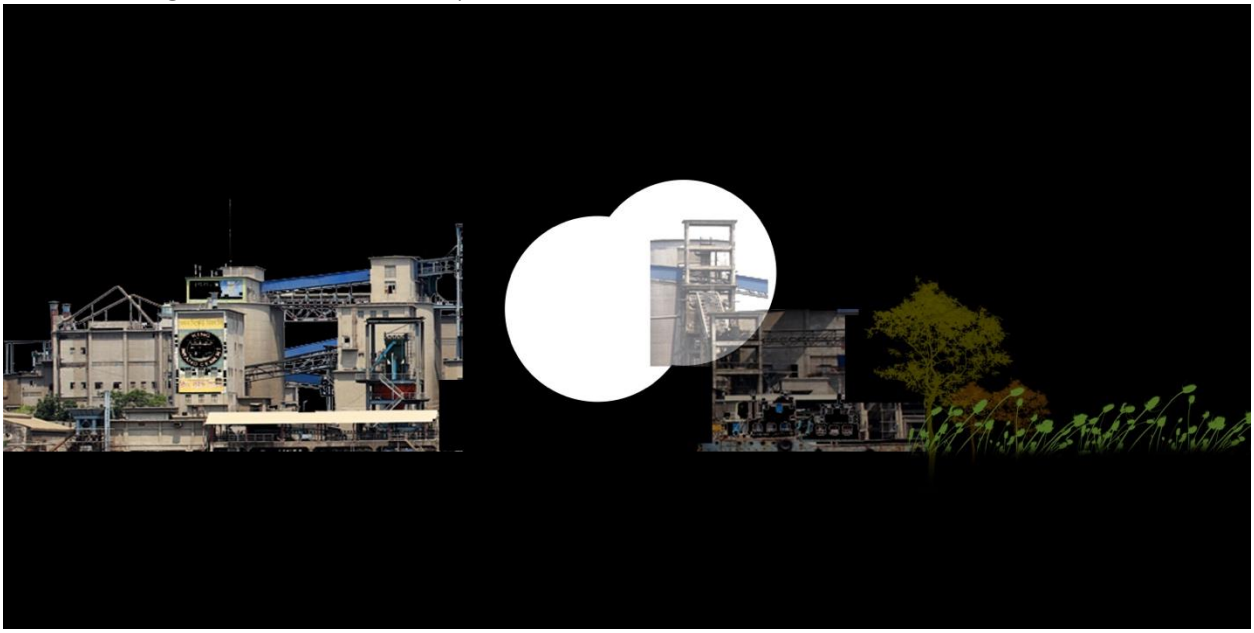
road network


south side and east side are blocked by large tanks of cement and oil.
North side and West side would thus be cooler because of the open field.
khulna mongla highway
direct access to the site
Directly exposed west side.
great amount of heat would be generated.
cement factory and oil refinery surrounds the site.
thus the site is secured from east and west.
©2007 Google™

Pictures around the site:



Initial montage done based on analysis:



2.4 SWOT analysis

2.4.1 Strength

One of strongest strength of this location is the main road at its eastern side. The road clearly exposes the site towards the other side creating a clean communication. The truck entries could use the secondary road whilst public and administrative entries could be from the main road. Also the structure is visible to any passerby on the main road.

2.4.2 Weakness

Weakness in this site to be precise is its lack of exposure to the direct Jetty itself. The unloading and loading is done by pipes although the direct access towards the jetty remains hard to access.

2.4.3 Opportunity

The vastness of the site and the easy accessibility to it helps to solve the industrial zone in a minimized area and leave more than 70 percent green area.

2.4.4 Threats

The adjusting factories pose a great threat to an already hazardous factory.

Chapter 3

3.1: Energy Distribution chain

The oil and gas industry is usually divided into three major sectors: upstream, midstream and downstream. The upstream oil sector is also commonly known as the exploration and production (E&P) sector.

The upstream:

The upstream sector includes searching for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil and/or raw natural gas to the surface. There has been a significant shift toward including unconventional gas as a part of the upstream sector, and corresponding developments in liquefied natural gas (LNG) processing and transport.

The downstream:

The downstream sector commonly refers to the refining of petroleum crude oil and the processing and purifying of raw natural gas, as well as the marketing and distribution of products derived from crude oil and natural gas. The downstream sector reaches consumers through products such as gasoline or petrol, kerosene, jet fuel, diesel oil, heating oil, fuel oils, natural gas, and liquefied petroleum gas (LPG) as well as hundreds of petrochemicals.

Midstream operations are often included in the downstream category and considered to be a part of the downstream sector.

The midstream:

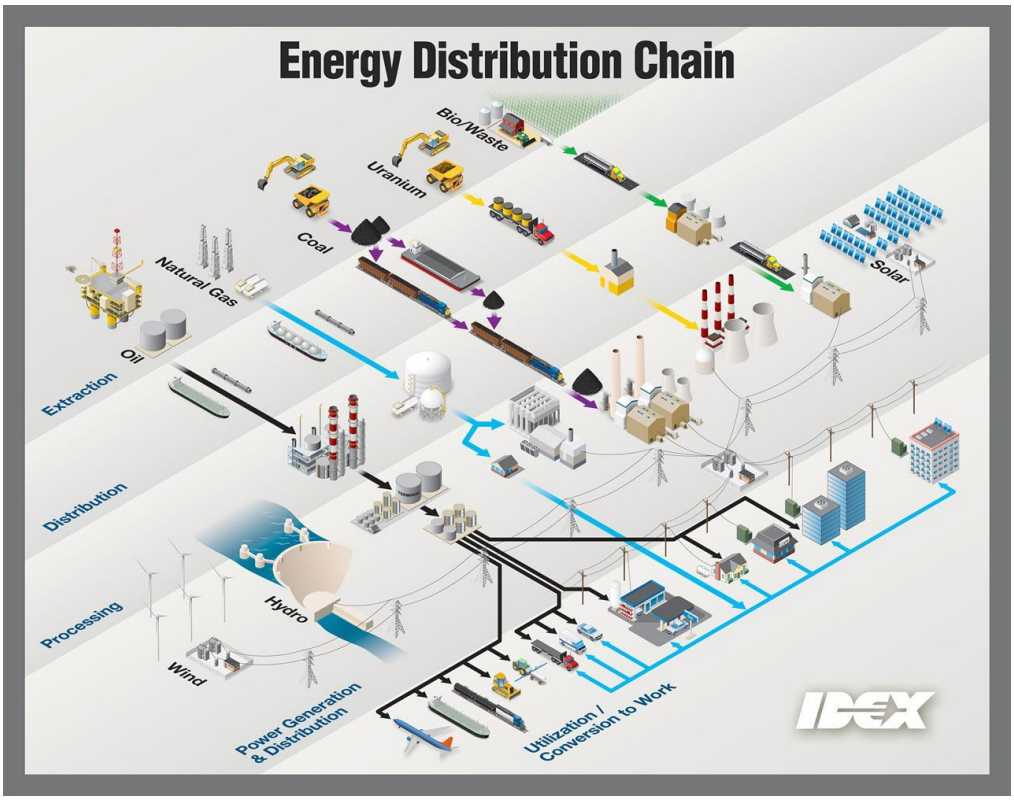
The midstream sector involves the transportation (by pipeline, rail, barge, oil tanker or truck), storage, and wholesale marketing of crude or refined petroleum products. Pipelines and other transport systems can be used to move crude oil from production sites to refineries and deliver the various refined products to downstream distributors.[1][2][3] Natural gas pipeline networks aggregate gas from natural gas purification plants and deliver it to downstream customers, such as local utilities.

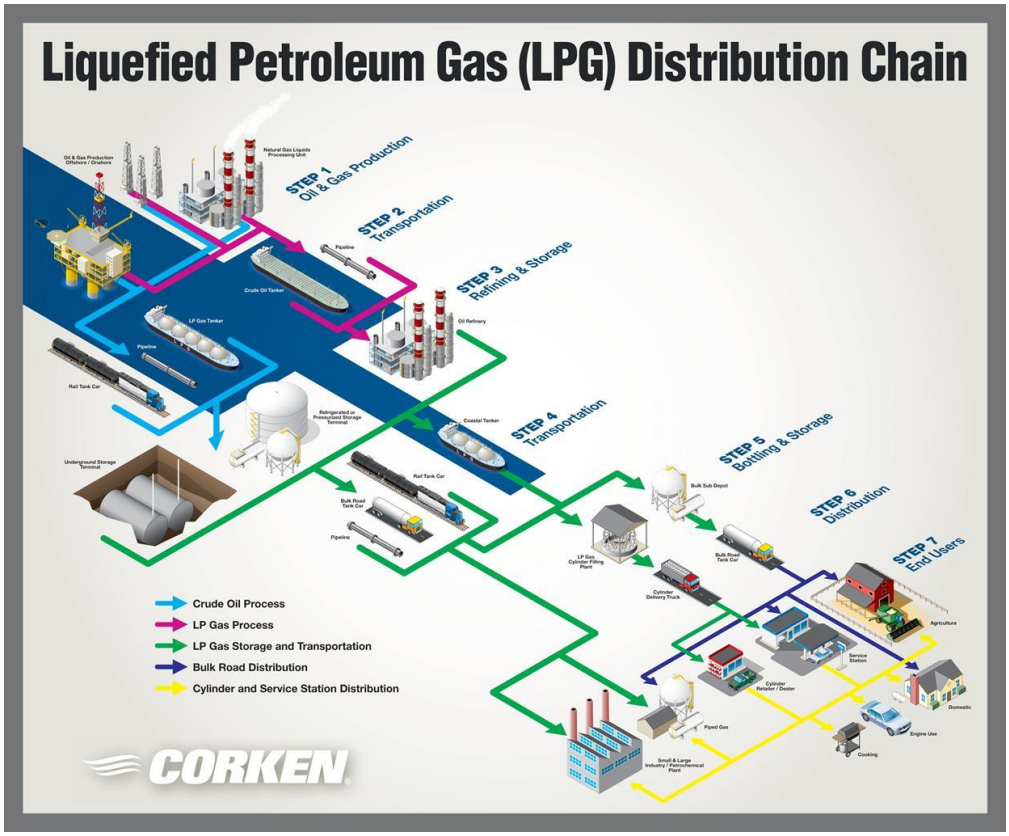
The midstream operations are often taken to include some elements of the upstream and downstream sectors. For example, the midstream sector may include natural gas processing plants that purify the raw natural gas as well as removing and producing elemental sulfur and natural gas liquids (NGL) as finished end-products.

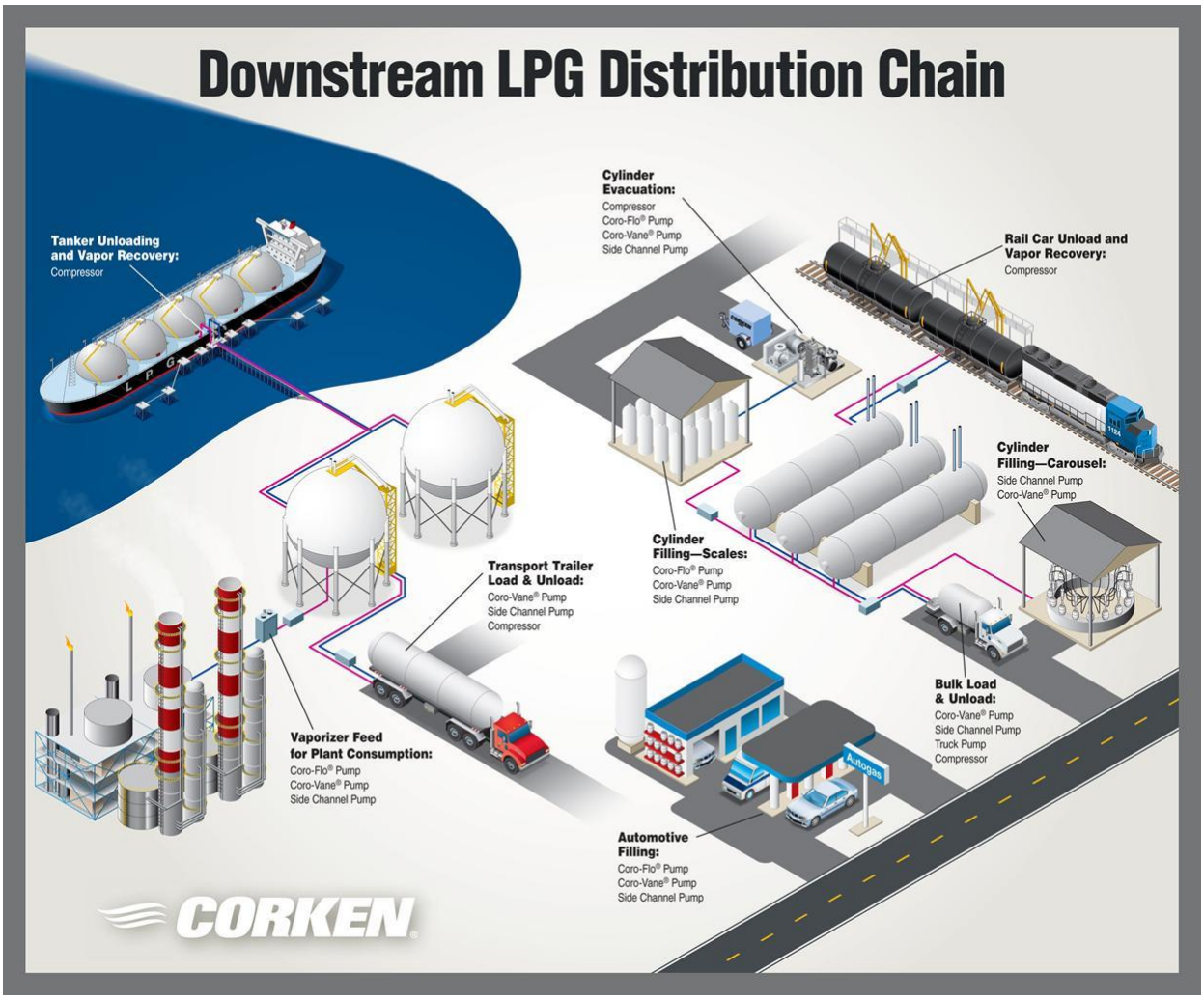
Midstream operations are sometimes classified within the downstream sector, but these operations compose a separate and discrete sector of the petroleum industry. Midstream operations and processes include the following:

- Gathering: The gathering process employs narrow, low-pressure pipelines to connect oil- and gas-producing wells to larger, long-haul pipelines or processing facilities.
- Processing/refining: Processing and refining operations turn crude oil and gas into marketable products. In the case of crude oil, these products include heating oil, gasolinefor use in vehicles, jet fuel, and diesel oil.[25] Oil refining processes include distillation, vacuum distillation, catalytic reforming, catalytic cracking, alkylation, isomerization andhydrotreating.[25] Natural gas processing includes compression; glycol dehydration; amine treating; separating the product into pipeline-quality natural gas and a stream of mixed natural gas liquids; and fractionation, which separates the stream of mixed natural gas liquids into its components. The fractionation process yields ethane, propane,butane, isobutane, and natural gasoline.
- Transportation: Oil and gas are transported to processing facilities, and from there to end users, by pipeline, tanker/barge, truck, and rail. Pipelines are the most economical transportation method and are most suited to movement across longer distances, for example, across continents.[26] Tankers and barges are also employed for long-distance, often international transport. Rail and truck can also be used for longer distances but are most cost-effective for shorter routes.
- Storage: Midstream service providers provide storage facilities at terminals throughout the oil and gas distribution systems. These facilities are most often located near refining and processing facilities and are connected to pipeline systems to facilitate shipment when product demand must be met. While petroleum products are held in storage tanks, natural gas tends to be stored in underground facilities, such as salt dome caverns and depleted reservoirs.
- Technological applications: Midstream service providers apply technological solutions to improve efficiency during midstream processes. Technology can be used during compression of fuels to ease flow through pipelines; to better detect leaks in pipelines; and to automate communications for better pipeline and equipment monitoring.

While some upstream companies carry out certain midstream operations, the midstream sector is dominated by a number of companies that specialize in these services.


Energy Distribution Chain
Bio/Waste
Uranium
Coal
Natural Gas
Oil
Solar
Extraction
Distribution
Processing
Hydro
Wind
Power Generation & Distribution
Utilization / Conversion to Work
IDEX


Liquefied Petroleum Gas (LPG) Distribution Chain
STEP 1 Oil & Gas Production
STEP 2 Transportation
STEP 3 Refining & Storage
STEP 4 Transportation
STEP 5 Bottling & Storage
STEP 6 Distribution
STEP 7 End Users
Crude Oil Process
LP Gas Process
LP Gas Storage and Transportation
Bulk Road Distribution
Cylinder and Service Station Distribution
CORKEN



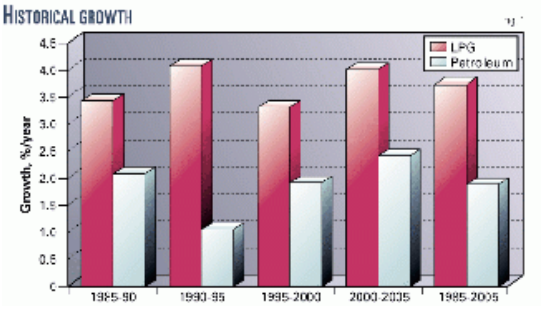
According to Justin Brown (July 2014) The oil and gas industry is generally divided into two areas: traditional operations—such as those that take place off the coast of Santa Barbara, Calif., in the Gulf of Mexico, or in Canada and Alaska—and exploratory operations, which include fracking. Each type of operation requires a different logistics strategy.

"The exploration and extraction supply chain is different than the supply chain from a well site to a refinery, especially in the people and processes involved," explains John Love, senior vice president and senior architect for Raleigh, N.C.-based logistics technology developer TMSforce.

3.2: History of LPG Industry

3.2.1 Historical growth of LPG:

For 1985-2005, Purvin & Gertz estimates that total LPG demand growth will average over 3.5%/year, while total petroleum demand over this same period will grow approximately 1.7%/year (Fig. 1).
The increased demand for LPG, mainly from petrochemical feedstock and residential-commercial end-use sectors, will change historical trade patterns for LPG during the next several years.
Historically, the region of the world east of the Suez Canal ("East of Suez") has had a surplus of LPG and has been a net exporter of product to the region west of the canal ("West of Suez"). The high growth of LPG demand in the Far East, coupled with additional petrochemical demand in the Middle East, will make East of Suez a net importer of LPG in 2000.



First mention of propane and butane mixture comes from as early as 1910. It was then that**Walter O. Snelling, an American chemist**ry researching properties of petrol, separated gaseous fractions from liquid ones, thus discovering the existence of propane. Two years later, in 1912, he started his first domestic propane installation, and in 1913 he patented producing propane on an industrial scale. Later that year the patent was bought by **Frank Philips, the founder of the ConocoPhilips** oil company. Even so, LPG consumption did not grow considerably. Information concerning practical use of LPG dates to 1918, when the fuel was **utilised for brazing lamps and metal-cutting blowtorches**. However, commercial production did not begin until the 1920's. LPG sales in the US topped **223 thousand gallons in 1922**, while within the next 3 years the figure **grew to 400 thousand gallons**. In 1928, LPG was **first used as motor fuel** (in a truck) and the first LPG refrigerator was made. In 1929, the level of sales of the fuel was as much as **10 million gallons** in the US.
LPG was gaining momentum rapidly. In 1932, it was **used for cooking and water heating** during the Olympic Games in Los Angeles. Propane-butane industry was growing stronger by the year and managed to produce and **sell 56 million gallons of LPG in 1934**. In the few following years, demand for liquefied petroleum gas was further **boosted by the popularity of airships**, regularly traveling between Europe and the US. The then latest-generation Zeppelin series airships were propelled by engines fueled with the so called **Blau gas** (invented by Herman Blau), itself very much alike butane – one of LPG's ingredients. Using gaseous fuel with roughly the same mass as

air was actually very convenient for airships as it did not alter a zeppelin's overall weight the way liquid fuels did (airships would become considerably lighter once liquid fuels were burned away, thus forcing the release of hydrogen, which was extremely dangerous).

3.2.3: What is LPG? Where does LPG come from? How is LPG made?

3.2.2 What is LPG? How is it made?

LPG – Liquefied Petroleum Gas – describes flammable hydrocarbon gases including propane, butane and mixtures of these gases. LPG, liquefied through pressurisation, comes from natural gas processing and oil refining.

Varieties of LPG bought and sold include mixes that are primarily propane (C3H8), primarily butane (C4H
10) and, most commonly, mixes including both propane and butane. In the northern hemisphere winter, the mixes contain more propane, while in summer, they contain more butane.[1][2] In the United States, primarily two grades of LPG are sold: commercial propane and HD-5. These specifications are published by the Gas Processors Association (GPA)[3] and the American Society of Testing and Materials (ASTM).[4] Propane/butane blends are also listed in these specifications.

Fig 2.1: LPG specification in Bangladesh

Properties	Propane	Butane	LPG (C3:30% & C4:70%)
General			
Physical state at 15°C and 1 atm	Gas	Gas	Gas
Molecular weight (gm/mole)	44.09	58.12	51-54
Boiling Point at 1 atm (°C)	(-) 42.1	(-) 0.5	(-) 13
Freezing point (°C)	(-) 187.7	(-) 138.4	(-) 153
Critical Temperature (°C)	96.67	305.6	243
Critical Pressure (psia)	616.25	551	570
Auto-Ignition temperature in air at 1 atm (°C)	470	500	490
Color (appearance)	Colorless	Colorless	Colorless
Odor	Odorless	Odorless	Odorless
Toxicity	Non toxic	Non toxic	Non toxic
Liquid			

Properties	Propane	Butane	LPG (C3:30% & C4:70%)
Reid Vapor Pressure (RVP) at 15.6°C (bars)	12	3.6	5-7
Gross Calorific Value at 15°C (kcal/kg)	11900	11800	11830
Net Calorific Value at 15°C (kcal/kg)	10999	10845	10896
Liquid density at 15°C (kg/litre)	0.51	0.575	0.5550
Specific volume of liquid per Kg at 15 C (litre)	1.96	1.73	1.7990
Specific gravity of liquid at 15°C (w.r.t water = 1)	0.51	0.575	&0.5555
Vapor			
Specific density at 15 C & 1 atm (kg/m3)	1.55	2.48	2.20
Specific Volume of Gas per kg at 15 C, 1 atm (m3)	0.5	0.38	0.42
Explosive limit (vol% of vapor in air gas mixture)	2.4 to 9.3	1.8 to 8.8	2 to 9.5
Gross Calorific Value at 15°C, (kcal/Nm3)	24000	30700	25226.67
Net Calorific Value at 15°C, (kcal/Nm3)	22600	29000	10896.36
Air required for combustion m^3/m^3	24	30	28

Where Does LPG Come From?

LPG comes from drilling oil and gas wells. It is a fossil fuel that does not occur in isolation.LPG is found naturally in combination with other hydrocarbons, typically crude oil and natural gas.LPG is produced during natural gas processing and oil refining. It is isolated, liquefied through pressurization and stored in pressure vessels.

According to Chris Woodford 2009, 2012. “As its name suggests, LPG is a fossil fuel closely linked to oil. About two thirds of the LPG people use is extracted directly from the Earth in the same way as ordinary natural gas. The rest is manufactured indirectly from petroleum (crude oil) drilled from the Earth in wells in the usual way.” Similarky the LPG that is being manufactured to Bangladesh are being imported from all over the world.

Their operations can be broken down as:

- Buying bulk LPG from foreign refineries or traders
- Shipping the bulk LPG to their terminals in Bangladesh via seagoing gas carriers
- Storing the bulk LPG into spheres or bullets via jetty pipeline
- Finally filling the gases into pressurized cylinders for onward distribution to the final consumers.

Ideally, once the customers use up all the gas, the empty cylinders are sent back to their respective operators for refilling.

How is LPG Made? What is the Production Process?

LPG is made during natural gas processing and oil refining.LPG is separated from unprocessed natural gas using refrigeration. It is extracted from heated crude oil using a distillation tower. This LPG can be used as is or separated into its three primary parts: propane, butane and isobutene stored pressurised as a liquid in cylinders or tanks.

3.3 The uses of LPG

What is LPG Used For? LPG Applications

LPG – Liquefied Petroleum Gas – is utilized in hundreds, if not thousands, of applications. LPG (propane) is used as a fuel for many residential, commercial and agricultural heat applications, including cooking, hot water systems and heating.It is also employed as a propellant, refrigerant, vehicle fuel and petrochemical feedstock.

LPG Uses in the Home

The three LPG uses most people can name are cooking, heating and hot water.
LPG for Cooking
There are many types of cooking appliances that use LPG. The most common are gas cooktops and ovens.
Gas cooktops are the preferred choice of professional as well as home chefs.
Outdoor cooking is also a popular application.
Everyone is familiar with LPG used for gas BBQs.
There are also LPG gas pizza ovens, spit roasters and smokers.

LPG for Heatings

The two most common LPG heaters types are ones that use LPG to generate radiant heat and convection heat.
LPG heaters can be portable, in-built consoles or an entire ducted heating system built into the home.
One of the most spectacular uses of LPG is for gas fireplaces & gas log fires.
These units use LPG to provide a rare mixture of beauty and warmth.

Gas fireplaces and gas log fire heaters can add to the ambiance of any room while supplying welcoming warmth to your entire home.
Although not common in Australia, hydronic heating is popular in Europe.
The LPG is used to heat the water that travels through a closed pipe system to radiators.
The radiators are positioned all the way through the home.
The hot water can also be used to heat in-floor systems, which provides heat that radiates upward.
LPG for Hot Water

LPG for Backup Generators

Using LPG to fuel backup generators has one really great advantage. LPG never "goes off" like diesel and petrol.
You can store LPG almost indefinitely without any degradation of the fuel.
LPG backup generators are very popular in the USA.
LPG for Off the Grid Generation
People who live off-the-grid (OTG) use LPG to generate their electricity.
LPG also supplements renewable solar energy sources, which are dependent on sunlight and weather.
New cogeneration units are now on the market that also produce heat in addition to electricity. These are known as Micro Combined Heat and Power (micro-CHP or MCHP) for the smaller sized units that are typically used in homes.

3.4: Why is LPG the fuel of future

Liquefied petroleum gas (LPG) is the most commonly used form of gas for transport in Australia (LPG is used in most Sydney taxis and some NRMA patrol vehicles). LPG is produced as a by-product of the oil refining process and during the production of natural gas. Australia has a comprehensive LPG network and it is cheaper than conventional fuels.

LPG requires a pressure tank to store the fuel. Most conventional cars can be converted to accept LPG as well as petrol. Some car manufacturers offer models with dual fuel LPG systems and Ford offers a dedicated LPG system on several Falcon models i.e. there is no petrol system in the vehicle at all. However, it is likely this will be phased out when Ford ceases manufacturing in Australia in 2016.

10 REASONS TO USE ALTERNATIVE FUELS

#1. Conventional fuels are going to run out
One day, our sources for traditional fuels including petroleum would be depleted. Owing to the fact that these fuels are typically not renewable, a lot of people are worried that a day would come when the demand for these fuels would be more than the supply, triggering a considerable world crisis. Non-

environmentalists also concur with the opinion that the majority of oil fields (situated in the Middle East) in the world are associated with problems – both political and economic. Determining a new method or solution with respect to finding different countries to create new fuels would reduce the unrest and conflict resulting from the world's dependence on fuel supply from the Middle East.

#2. To reduce pollution

The use of alternative fuels considerably decreases harmful exhaust emissions (such as carbon dioxide, carbon monoxide, particulate matter and sulfur dioxide) as well as ozone-producing emissions.

#3. To protect against global warming

According to a commonly accepted scientific theory, burning fossil fuels was causing temperatures to rise in the earth's atmosphere (global warming). Though global warming continues to be just a theory, a lot of people across the globe are of the belief that discovering sources of cleaner burning fuel is an essential step towards enhancing the quality of our environment.

#4. To save money

Alternative fuels can be less expensive to use not just in terms of the fuel itself but also in terms of a longer service life. This in turn means savings for the long term.

#5. Can reuse waste

Biofuels, bioproducts, and biopower provide modern and fresh relevance to the old belief that trash for one person is a treasure for another. That's good news considering that Americans produce in excess of236 million tons of waste each year.

#6. More choices

People are different. Each person has his own requirements, opinions, and preferences. One great thing about alternative fuels and the corresponding vehicles that run on them is that there is something to suit any lifestyle.

#7. You'll be helping the farmers

The use of biofuels that depend on crops produced and processed locally help to support farmers for their dedicated and hard labor. Biodiesel and ethanol cooperatives are a result of the great outmoded farmer cooperatives that assist with returning power to the hands of the people.

#8. Can frequently be produced domestically

Often, alternative fuels can be developed domestically, utilizing a country's resources and thereby strengthening the economy.

#9. Fuel economy

Vehicles driven on hydrogen fuel cells and diesel are more economical with respect to fuel compared to an equivalent gasoline vehicle.

#10. More convenience

Wireless charging is one of the factors that make alternative fuels more convenient. Automaker Nissan already displayed the technology in concert along with a parking assist system which mechanically guides the vehicle to its "docking station" or parking spot. The driver just presses a button or utters a command, releases control over the wheel, and the vehicle takes care of the rest. Once the vehicle is parked, the driver just turns the car off, closes the door, and carries on with his business. No need to go the gas

station and no plugs. All that's required is low-cost electricity and adequate gas in the tank whenever you have to travel in your car.
More and more onboard sensors now provide cars with the ability to tackle the most challenging driving tasks such as modifying cruise speeds to suit traffic situations in real time, emergency stops, and parking. In combination with Advanced Driver Assistance Systems and Advanced GPS navigation, we can soon expect a day to come when driving would be absolutely "hands free."
The development of the 'connected car,' characterized by seamless communication of the automobile with sensor onboard systems of its own, in addition to road and signal infrastructure, so as to decrease time expended in traffic, prevent accidents, and connect occupants to the web by way of mobile and on-board devices – is triggering increased electrification for vehicle architectures.

3.5 Understanding the role of architecture in an Industry

Role of an architect

An **architect** is a person who plans, designs, and oversees the construction of buildings. To practice **architecture** means to provide services in connection with the design and construction of buildings and the space within the site surrounding the buildings, that have as their principal purpose human occupancy or use

Why is there a need for architects in an industry?

- Architects see the big picture.
- Architects are specially educated to help define what is needed to build, present options that might never have considered, and helps get the most of the valuable investment. They don't just design four walls and a roof -- they create total environments, both interiors and exteriors, that are functional and exciting places in which to work and live.
- Architects solve problems creatively. Architects are trained problem solvers. Architects can show how to enlarge space so that there is no need to change the whole structure. Architects can propose ways to get more from the investment.
- Architects can reduce building costs, decrease energy needs, and increase its future resale value through good design.

3.6 Understanding 'awareness' of an architect in LPG Industries

The safety matters in a LPG industry usually leads to poor design and condition without keeping in mind that there are people working at that space 24/7. An architect will design the space functionally and according to its psychological needs of the people working in it.

1) Open Office Spaces Foster Communication:
In the old days, office space was distributed in the same general manner, no matter what company. The newbies were given cubicles, mid-management got to enjoy the privilege of an office with a door, and CEOs had their pick of palatial spaces with stunning views. But, today, those offices are quickly becoming a thing of the past in favor of large, open spaces.

This type of environment features long workspaces where a new hire and a CFO could potentially work side-by-side. Even the conference rooms, though enclosed, usually feature glass walls. Some companies like Twitter even go the extra step and configure their buildings entrance so that employees must pass through a high-end communal break room before continuing on to their departments.

What's the benefit of all this openness? Communication. Research has pointed to the fact that workers are more likely to communicate with each other for project details and assistance problem-solving if they have mingled socially.

The other benefit of this type of space is, obviously, accountability. With no solid walls or doors, workers experience a sort of "fish bowl effect" and are more likely to stay focused on the task at hand.

2) Task-Based Workstations Improve Productivity:
Instead of each employee having an assigned desk, distinct spatial configurations are setup for the workers to use as needed. There might be open desks for computer work, round tables for creative brainstorming, and secluded cubbies for quiet concentration. Typically, employees are also given mobile technology to allow them to move freely throughout the space.

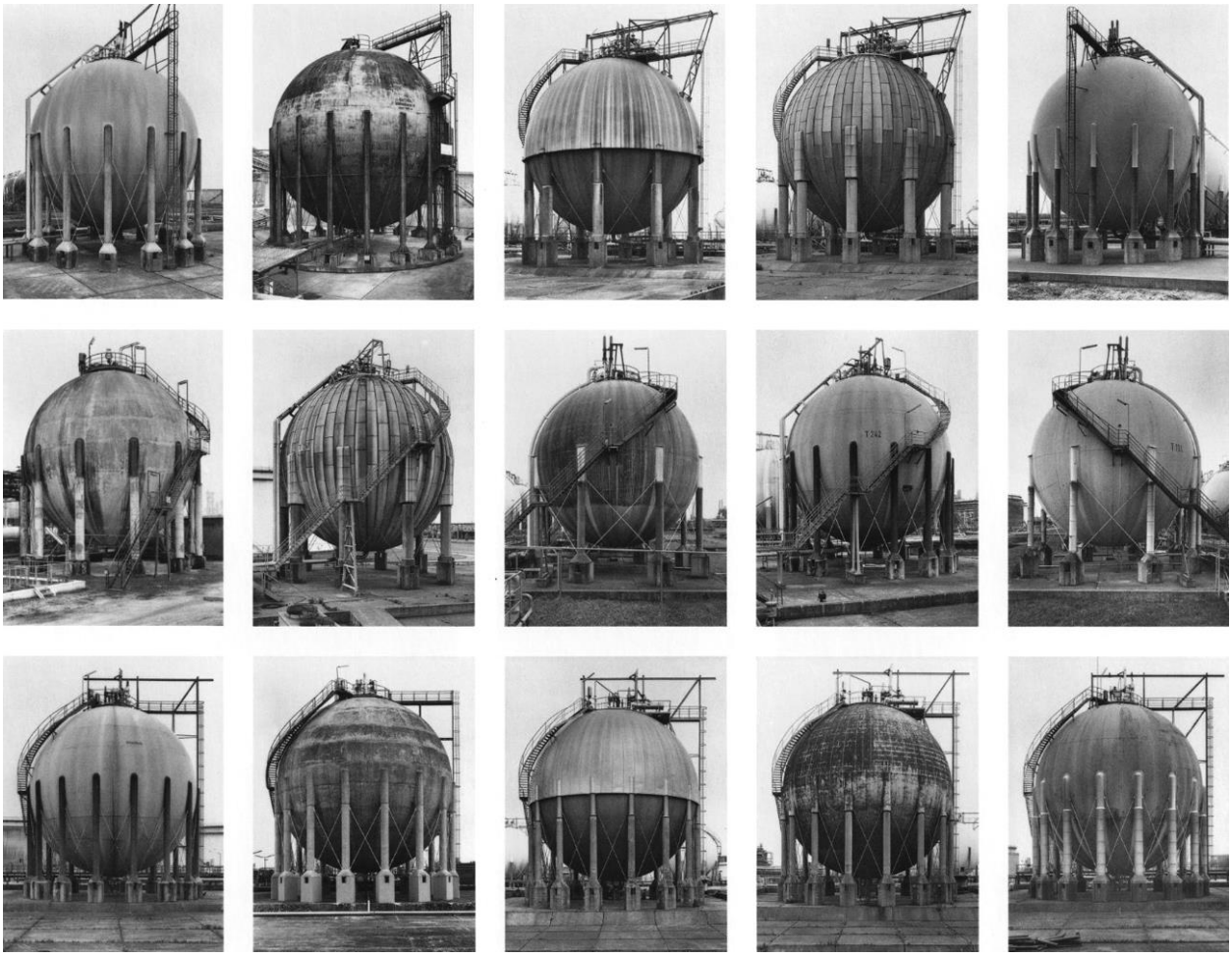
This type of flexibility allows workers to place themselves in the environment in which they work best. Introverts are allowed a peaceful place to collect their thoughts while extroverts can feed off of each other's energy. Allowing that freedom of choice has shown increases in productivity for forward-thinking companies like Google and Department of Treasury and Finance in Victoria.

3) Natural Light Improves Quality of Life:
Is there anything more depressing than overhead office lights? It's almost as if the sound of that unmistakable buzzing has been burned into our brains and associated with long hours and unshakable colds that leave the entire staff taking sick days. However, corporations are quickly discovering that if they want to keep their employees healthy, they need to hit the off switch and let the sun in.

A recent study from Northwestern Medicine and the University of Illinois at Urbana-Champaign compared the overall health of workers who had window-filled offices versus those without. They found that employees with windows received 173% more white light exposure during work hours and slept an average of 46 minutes more per night. Those employees also reported greater physical activity than their collogues who were left in the dark.

Anyone who has gone into work on a poor night's rest knows that an improved quality of life will translate into improved work performance. In order to bring these results into your office, research suggests that corporations choose buildings that feature floor-to-ceiling windows as their workspace. Once there, they should make sure to keep workstations within 20 to 25 feet since that is the limit to how far natural light can travel.

3.7: Tank Typologies



Initially, Hortonspheres were constructed by riveting together separate wrought iron or steel plates, but from the 1940s, were of welded construction. The plates are formed in roller plants and cut to patterns.

CBI accounts for a large proportion of spherical pressure vessels in the world. They are used extensively for LPG, as well as for other volatile gasses. CBI identifies the following uses: gasoline, anhydrous ammonia, vinyl chloride monomer (VCM), naphtha, propane, propylene, ethane, butane, NGL and butadien. Cryogenic storage is also possible for LNG, methane, ethylene, hydrogen and oxygen. Gases that may be stored include hydrogen, nitrogen, oxygen, helium and argon. Other uses have been applied to the Hortonsphere including space chambers, hyperbaric chambers, environmental chambers, vacuum vessels, process vessels, test vessels, containment vessels and surge vessels.

Chapter 4

4.1 Introduction to case studies

Case study research excels at bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research. Case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships. Researchers have used the case study research method for many years across a variety of disciplines. Social scientists, in particular, have made wide use of this qualitative research method to examine contemporary real-life situations and provide the basis for the application of ideas and extension of methods. Researcher Robert K. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used

Many well-known case study researchers such as Robert E. Stake, Helen Simons, and Robert K. Yin have written about case study research and suggested techniques for organizing and conducting the research successfully. This introduction to case study research draws upon their work and proposes six steps that should be used:

- Determine and define the research questions
- Select the cases and determine data gathering and analysis techniques
- Prepare to collect the data
- Collect data in the field
- Evaluate and analyze the data
- Prepare the report

4.2 CASES

The cases below have been chosen both locally internationally and hypothetically. Through the reference by these case studies the project was derived.

4.2.1 Bashundhara LPG at MONGlA

Bashundhara LP Gas Ltd is the first private LPG plant in the country. It has a higher production rate than any other filling station in Bangladesh. It possesses 3000MT storage capacity, which is the largest amount among all the LPG plant in Bangladesh. LPG is an intermediate product that is situated between natural gas and crude oil. LPG is one of the common fuels in our country where natural gas is not available. Gradually it has become a very popular fuel in our country.Bashundhara Group was the first business entity in country's private sector to start importing, bottling and marketing of LP Gas. The company has state-of-the-art LP Gas plant in Mongla which houses 6 gas storage tanks with a capacity of 500 metric ton each. And the 48 filling posts of Carousel Filling System of the plant have daily refill capacity of 50,000 units of Gas Cylinders.

Specification of LPG bottle

- Water capacity :c.a.26.6 lit(12Kg)&108lit(45 Kg).
- LPG capacity :12 Kg, 30 Kg & 45 Kg
- Service Pressure :17 Kg/ cmï¿½
- Hydrostatic testing pressure :34 Kg/ cmï¿½
- Internal Valve pad threading : ¾ inch NGT
- Cylinder valve :KOSAN gas valve type186G001 (22mm version) or any compatible Centre valve type.

LPG Cylinder In operation:

At present the plant has a 12 Kg 30Kg & 45 Kg of LPG cylinders in operation.

The main composition of LPG to be stored and bottle as follows:

Propane content : 20-50%

Butane content : 80-50%

The LPG will not contact corrosive components according to international rules and practice.

Product Usages:

12 Kg : Domestic Use
30 Kg : Domestic Use, Industrial Use & Commercial Usages.
45 Kg : Industrial Use & Commercial Usages.

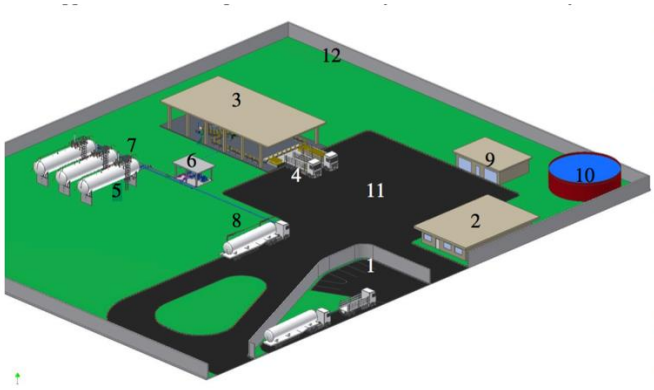
4.2.2 Kosan crisplant

Kosan Crisplant is considering a complete plant on turnkey basis with all facilities according to HSE - Health - Safety - Environment and the local standard/regulations.

Stationary plant for filling of approx. 400 domestic LPG cylinders per hour up to approx. 1200 LPG cylinders per hour.

The area required for the whole LPG filling plant is approx. 100 m x 120 m.

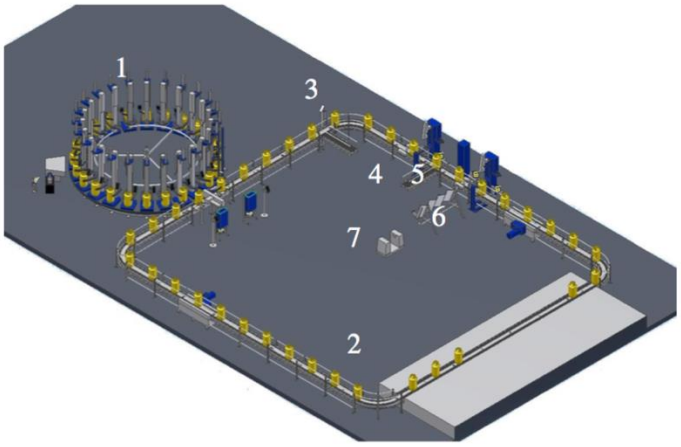
A minimum number of LPG cylinders should be available to introduce to the market when starting the operation. If you have 100,000 cylinders and you are filling 1200 cyl/hour you have enough cylinders for approx 3 months of operation. Then the cylinders starts to be recycled from the consumers



1. Parking area
2. Adm. building with cantina, relaxing area and gate house
3. Filling hall
4. Cylinder loading and unloading
5. Storage vessels
6. LPG pump house
7. LPG pipe installation
8. LPG supply - Loading/unloading point
9. House with firewater pump, air compressors and electrical supply
10. Firewater tank /basin
11. Area for trucks and handling
12. Fence and security

Example of a filling station layout for a stationary plant

Electronic filling carrousel (top), leak detection (left) and check weighing (right)



1.Filling carousel 3.Check scale 5.Sealing 7.Valve changing
2.Conveyor system 4.Leak detector 6.Evacuation of LPG

Filling hall layout

Safety and a high capacity of the LPG filling plant is the main focus for Kosan Crisplant.

The handling of the LPG cylinders in also a very important factor in the whole process. For instance, the internal transportation of cylinders from the unloading to the filling and back to the truck can be fully automated.

Filling takes place on an electronic filling carrousel, and the cylinders will be automatically check weighed and leak detected. Sealing of the cylinder valve can also be fully automated.

Moreover, it can be an idea to equip the large plants with telescopic conveyors for easier cylinder handling or with a pallet plant for an optimized logistic solution also for the distribution to the depots.

Generally, the need of automation increases according to an increase in production. Kosan Crisplant delivers carousel systems ranging from 8 to 72 stands with capacities up to 3600 cylinders/hour from a single carousel.

Additional processes in the filling hall could be cylinder washing, base ring straightening, labeling, valve changing, etc. for a higher level of cylinder performance.

Above ground storage tank incl. fire water piping

Fire water tank incl. fire water piping

LPG Supply and Stocking

In connection with the LPG filling plants, the product (LPG) can arrive in different ways;

By semi-trailers,

. By train

. By ship via (jetty)

. By a pipeline from the refinery. And LPG is then reloaded via the loading point to the storage tanks at the filling plant. The pump room contains the necessary LPG pumps and compressors for the LPG transportation also for the supply to the filling carrousel in the filling hall.

Matrix for bullet tanks.

		VOLUME m3	DIAMETER mm	LENGTH mm	THICKNESS mm	WEIGHT tons
PRODUCT	BUTANE	100	3 000	18 000	8	14
CODE	EN 13455	150	3 000	27 000	8	20
STEEL	P355 NL1	200	3 200	27 000	10	26
PRESSURE		250	3 400		12	

	8 BAR			28 000		32
		300	3 600	30 000	13	38
		350	3 800	32 000	14	46
		400	3 800	36 000	14	51

Administration and Technical Rooms

In the administration building the gatehouse can be located together with the control room for the overall monitoring of the LPG consumptions, etc. In connection with the operation of the plant, the following will be required:

. Power from the central switch board, supplied by the local transformer (can also be placed in the electrical room)

. Compressed air supply from air compressors located in the technical room

. Supply of utility water (cleaning, lubrication of conveyor, etc.)

. Staff related issues as cantina, relaxing area, baths, toilets and parking area Turnkey Greenfield Project Stocking capacities, required capacity, local access road, soil conditions, building style, personnel space requirements, drains, etc. determine the complete project for the Greenfield project. When a suitably sized land has been pointed out in the project, the engineering work will take off and a final general layout of the plants can now be determined. The scope of the engineering work can among other things involve:

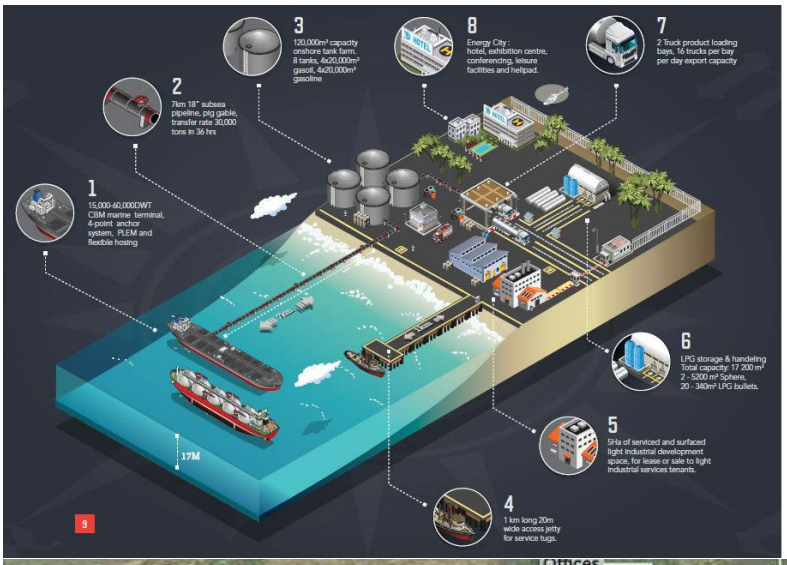
- Feasibility studies
- Site inspection
- General layout
- Tank design / PED dossier
- Foundation drawings
- P & I diagrams
- 3D piping (LPG, Fire water .utility water and air supply)

- Filling hall drawing
- Etc.

4.2.3 FIFC oil products import/export trading terminal

The FIFC oil products import/export trading terminal will consist of an off-shore CBM marine terminal, an onshore tank farm, 5ha light industrial space, offices, LPG storage farm, Gasoline and LPG distribution facilities and an “Energy City”, to be developed on 2 portions of land totalling 20.5ha.

The Apam Storage Depot (Tank farm) aims to serve both the local and the regional markets with products
imported by FIFC stored and purchased by local Oil Marketing companies (OMC) and the Bulk Distribution
Companies (BDC), who have limited storage, hiring space for their imported products. The site is a green-fields site with essential utilities such as water and electricity and as such, an ideal piece of land for future expansion without the constraints associated with similar developments as experienced in other parts of the country. As the Tank farm sits on the coast not far from the countries of Togo, Benin and Nigeria, oil marketing companies in these countries can also use the facility. In Nigeria, the Apapa port is mostly congested and as a result ships wait for weeks to discharge their cargo. These Nigerian products importers can save cost on demurrage when they offload at Apam, then use small vessels to supply their depots in Nigeria when needed.



Area A Facilities

1. 15,000-60,000DWT CBM marine terminal, 4-point anchor system, PLEM and flexible hosing
2. 7km 18” subsea pipeline, pig gable, transfer rate 30,000 tons in 36 hrs

3. 160 000m3 capacity onshore tank farm. 8 tanks, 4x 20 000m3 gasoil, 4x 20 000m3 gasoline
4. 1 km long 20m wide access jetty for service tugs.
5. 5Ha of serviced and surfaced light industrial development space, for lease or sale to ligh industrial services tenants.

STORAGE FACILITY

A gasoline and gas oil storage terminal consisting of eight storage tanks with a total storage capacity of 160 000m3. Fire-fighting and workshops facilities are planned to service the storage terminal.

LPG storage & handeling
Total capacity: 17 200m3
• 2x 5200m3 Sphere,
• 20x 340m3 LPG bullets.

2. Truck product loading bays

16 trucks per bay per day export capacity

3. Energy City :
• Hotel (100 beds)
• Exhibition centre
• Conferencing
• Leisure facilities • Helipad.

ENERGY CITY

The concept of the Energy City is to provide a state of the art destination aimed at both the tourism industry and the oil and gas sector. The hospitality market is growing the world over and Ghana is no different having shown a steady increase in the number of oil and gas related conferences, especially since the discovery of oil and gas fields in 2007. The recent opening of the Four Star Royal Senchi Resort near Akosombo has also shown that there is a demand for such developments.

Chapter 5

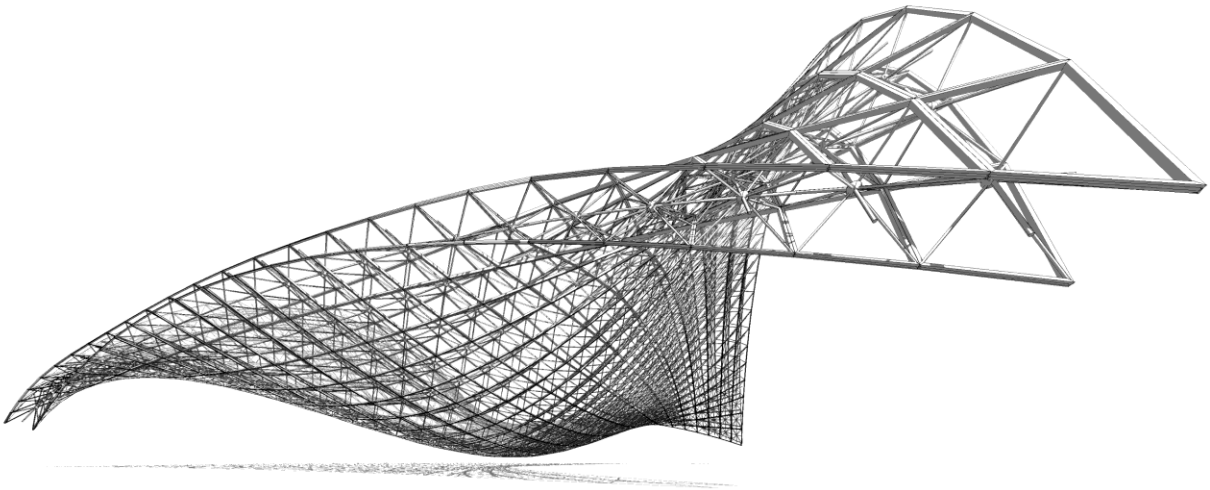
5.1 Program development
5.2 Plans and concept
5.3 sections
5.4 Montages

5.1 Program development

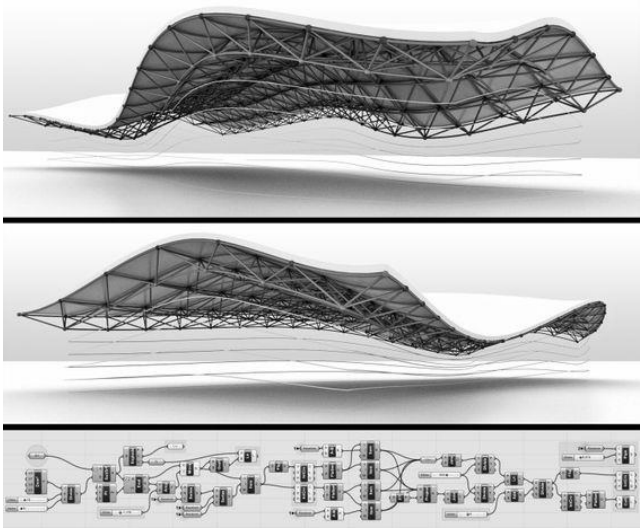
The development of the project strated from a single idea of understanding the workers psychological needs and adding the importance of the role of an architect in an industry.

5.2 Plans and concept

Introduction of amorphous space in the working area

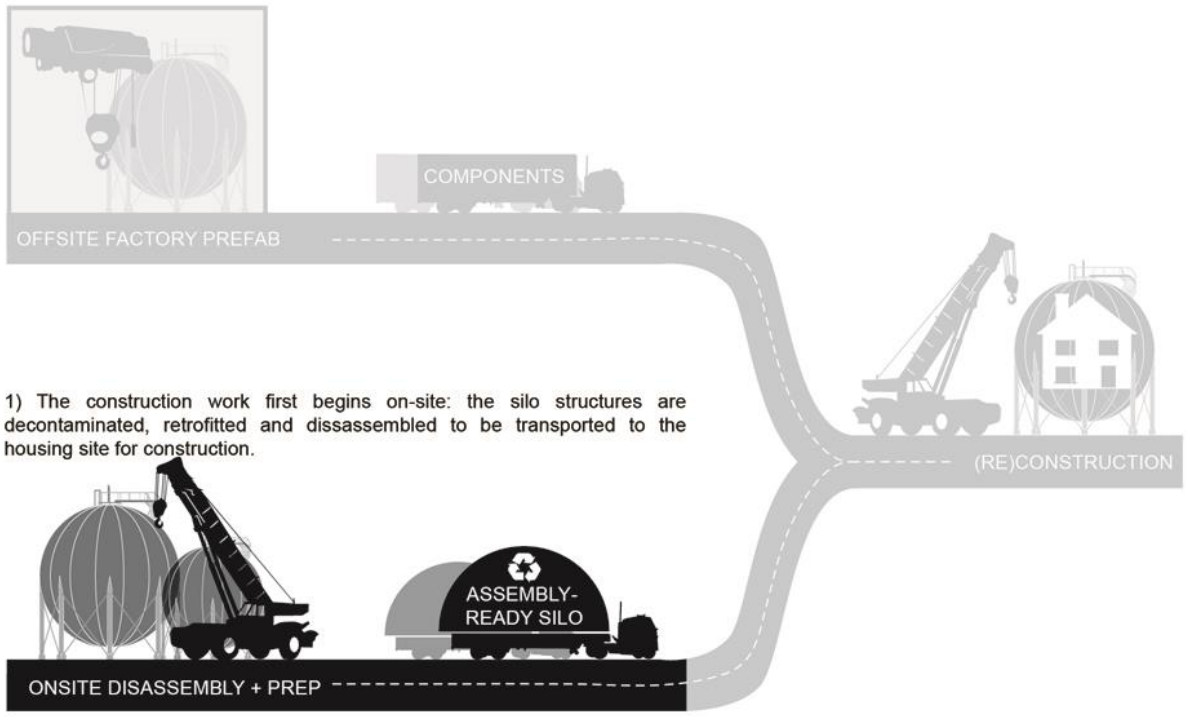


The hierarchy of spatial quality breaks the monotone of long hours

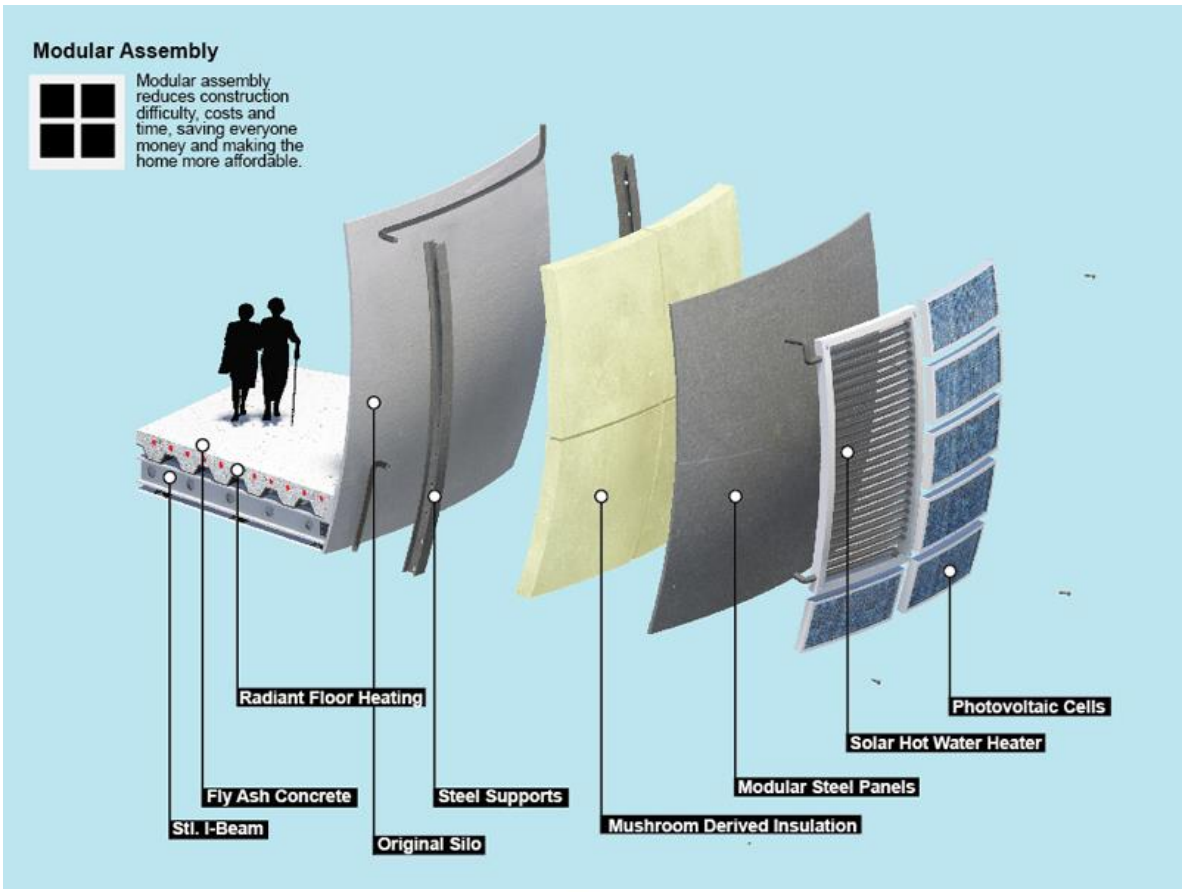


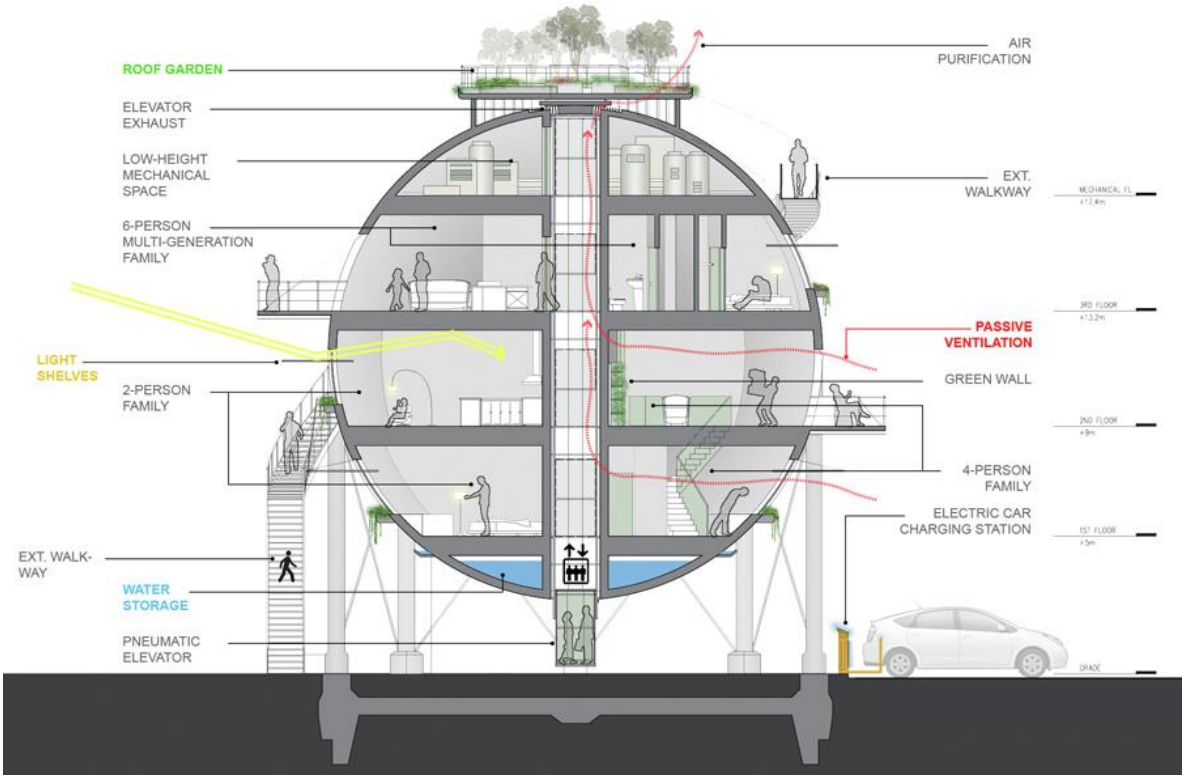
Using reused materials from scrap and other silo structures:

Example 1 : Pinkcloud Oil silo home



PinkCloud designed the Oil Silo Home to create more energy than it uses, with solar panels, natural lighting, and passive heating and cooling. And with its “strong structural rigidity, flexible suspension, waterproof shell, and aerodynamic design,” it could presumably endure whatever extreme weather events might be in store in future decades. According to PinkCloud, these silos could be decontaminated and retrofitted on site, transforming entire refineries into sustainable communities

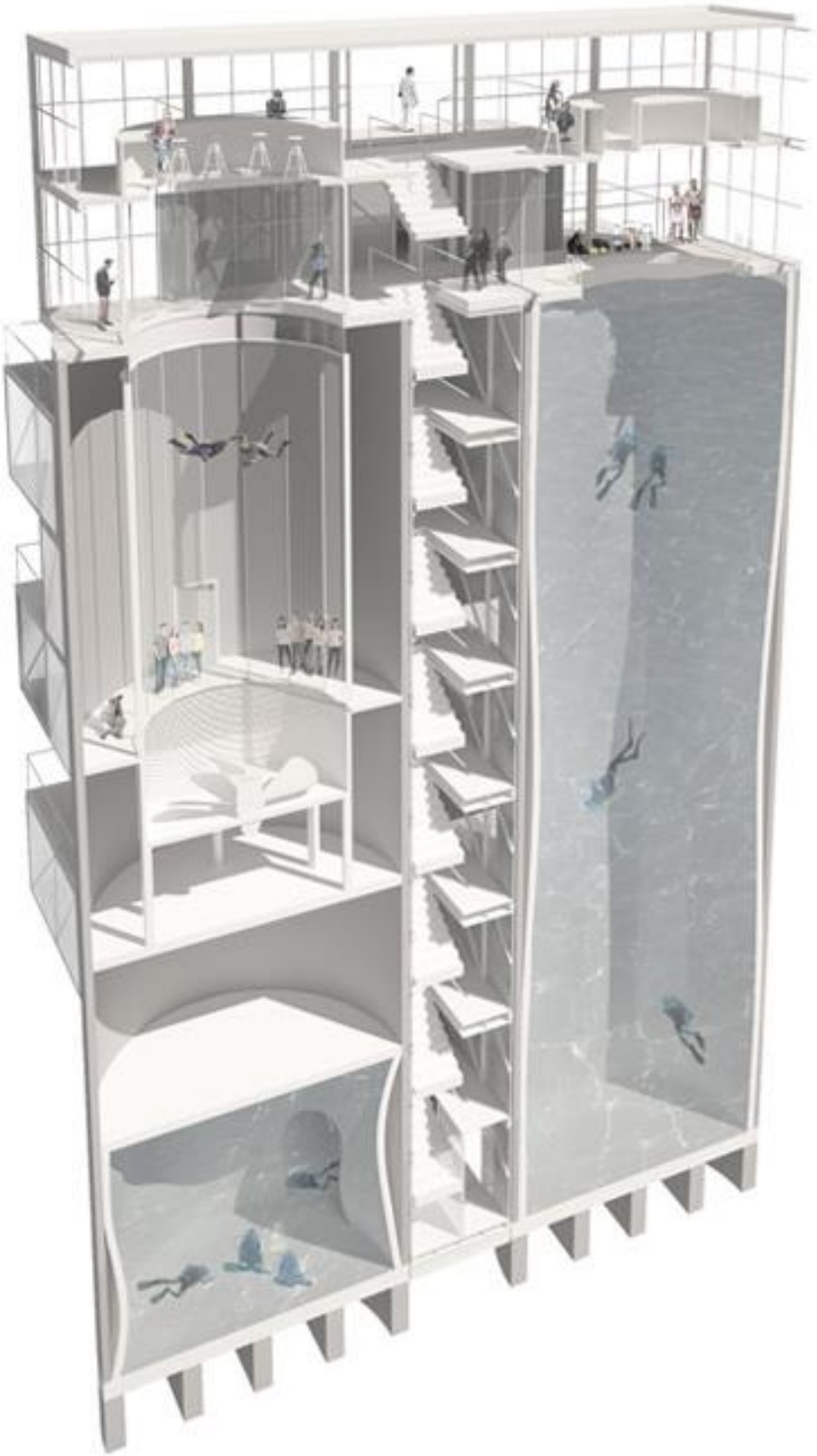

Modular Assembly
Modular assembly reduces construction difficulty, costs and time, saving everyone money and making the home more affordable.
Radiant Floor Heating
Fly Ash Concrete
Stl. I-Beam
Steel Supports
Original Silo
Mushroom Derived Insulation
Modular Steel Panels
Solar Hot Water Heater
Photovoltaic Cells


ROOF GARDEN
ELEVATOR EXHAUST
LOW-HEIGHT MECHANICAL SPACE
6-PERSON MULTI-GENERATION FAMILY
LIGHT SHELVES
2-PERSON FAMILY
EXT. WALK-WAY
WATER STORAGE
PNEUMATIC ELEVATOR
AIR PURIFICATION
EXT. WALKWAY
PASSIVE VENTILATION
GREEN WALL
4-PERSON FAMILY
ELECTRIC CAR CHARGING STATION

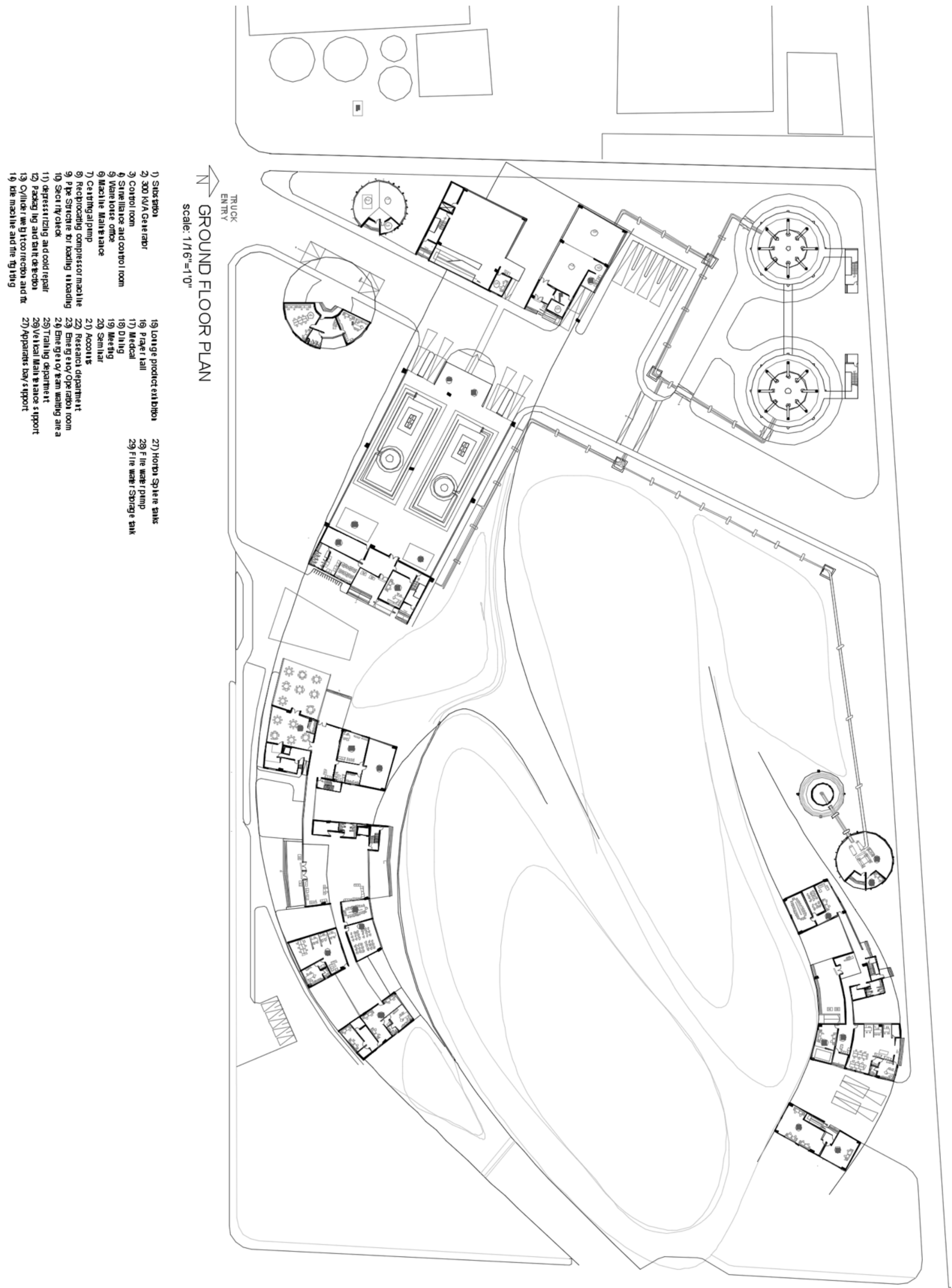
Example 2: Skydiving planned in abandoned Warsaw cement silo

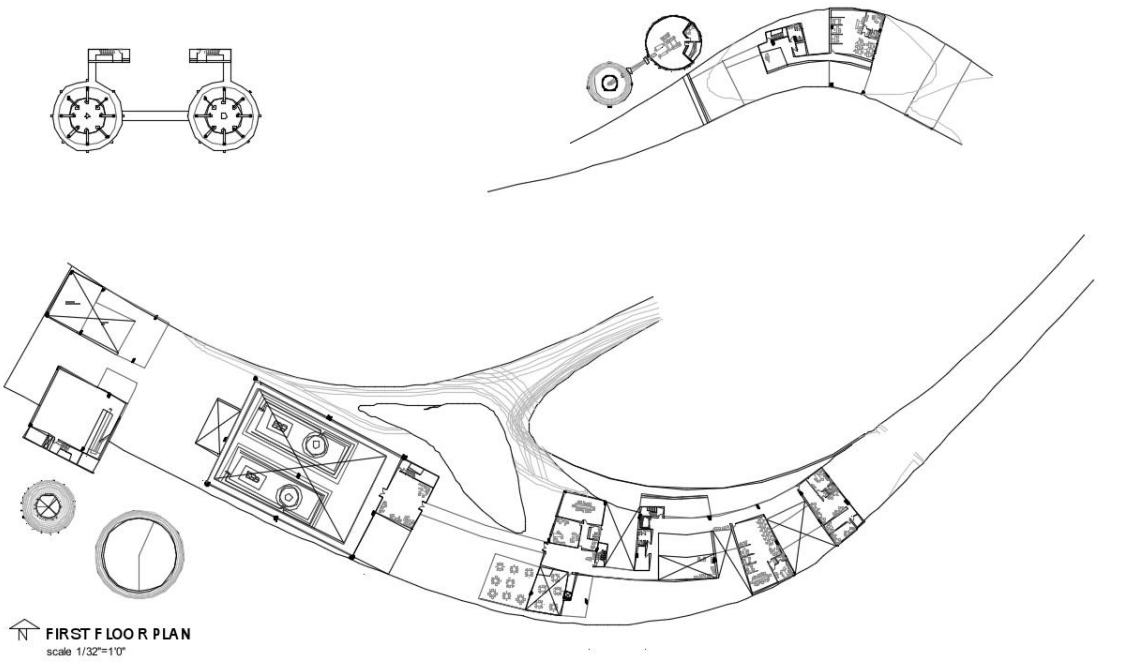
Moko's plan is to pile up shipping containers around a couple of obsolete cement silos to create a 10-storey structure. The sky-diving would happen in one of the cylindrical silos (converted with viewing platforms half way down, for the purpose), while the second one would be filled with water so that divers could plunge – if they chose to - into 25m of water.

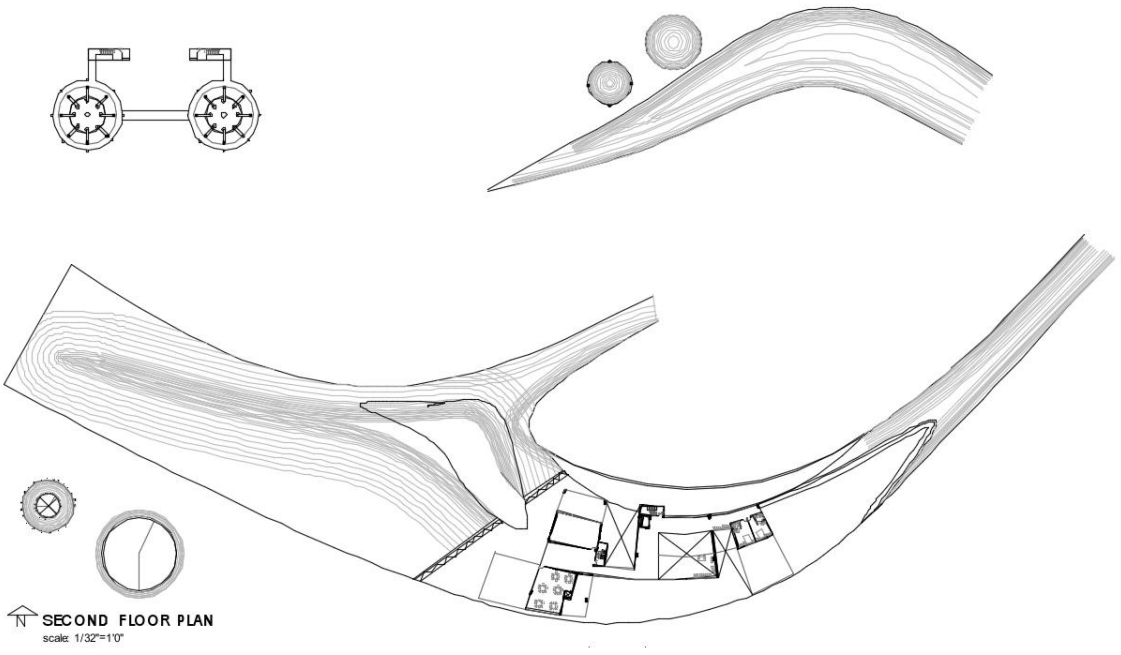
In the base of the sky-diving tower, there would be an underwater cave measuring 7m in diameter, where enthusiasts could train in wreck diving. Meanwhile those shipping containers will house offices, training facilities, a hostel for divers, exhibition space, reading room, sports equipment stores, and a café during the summer. By piling up the containers in an ad hoc fashion, Moko will form balcony terraces on the external landings.
It's all planned for Zeran, a down-at-heel industrial district which boasts a number of defunct factories and warehouses. However, the area does have one thing going for it: a system of channels which transport water between Warsaw and the Zegrze Reservoir.
"The collection of elements has a huge potential," Moko believes, "The channel provides the opportunity of doing water sports and staying active.

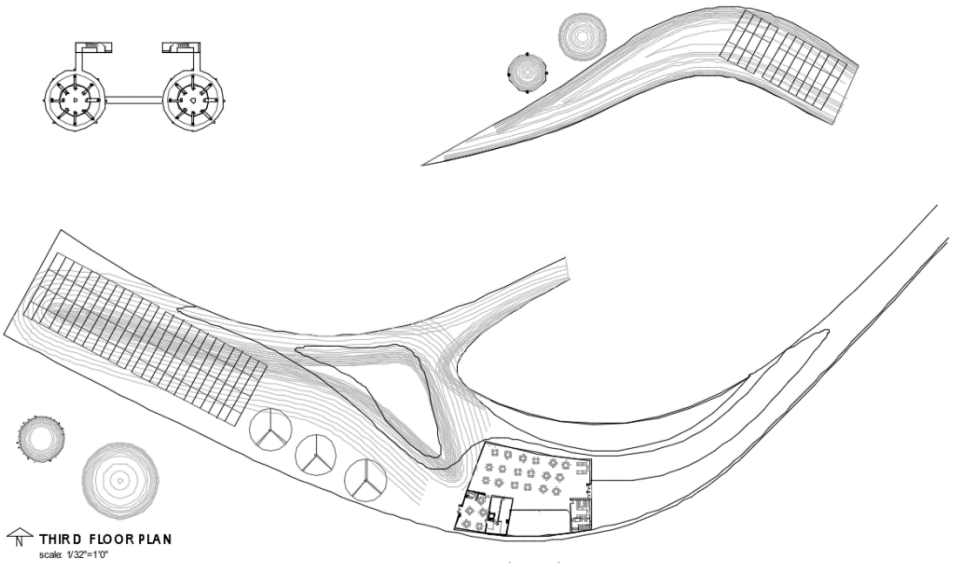


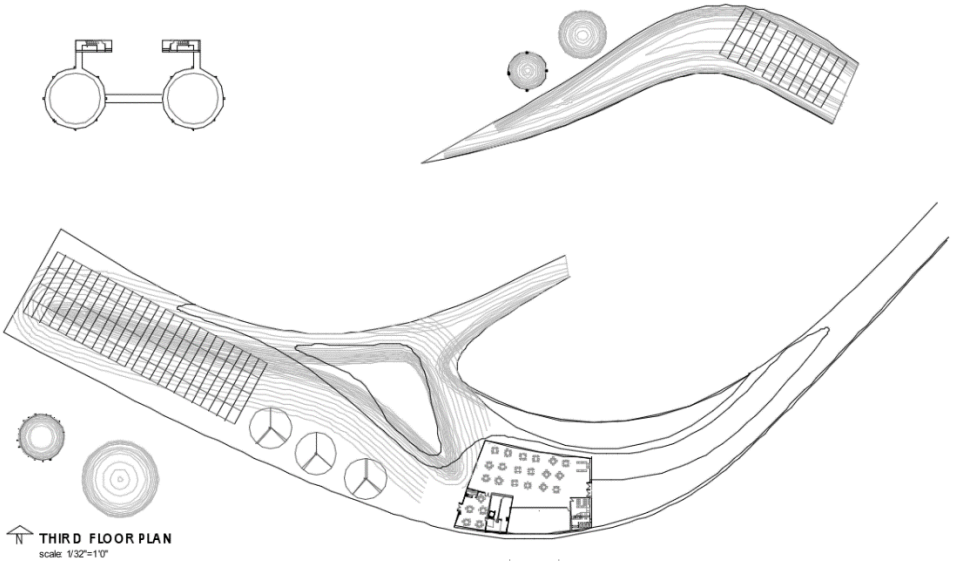
Plans:



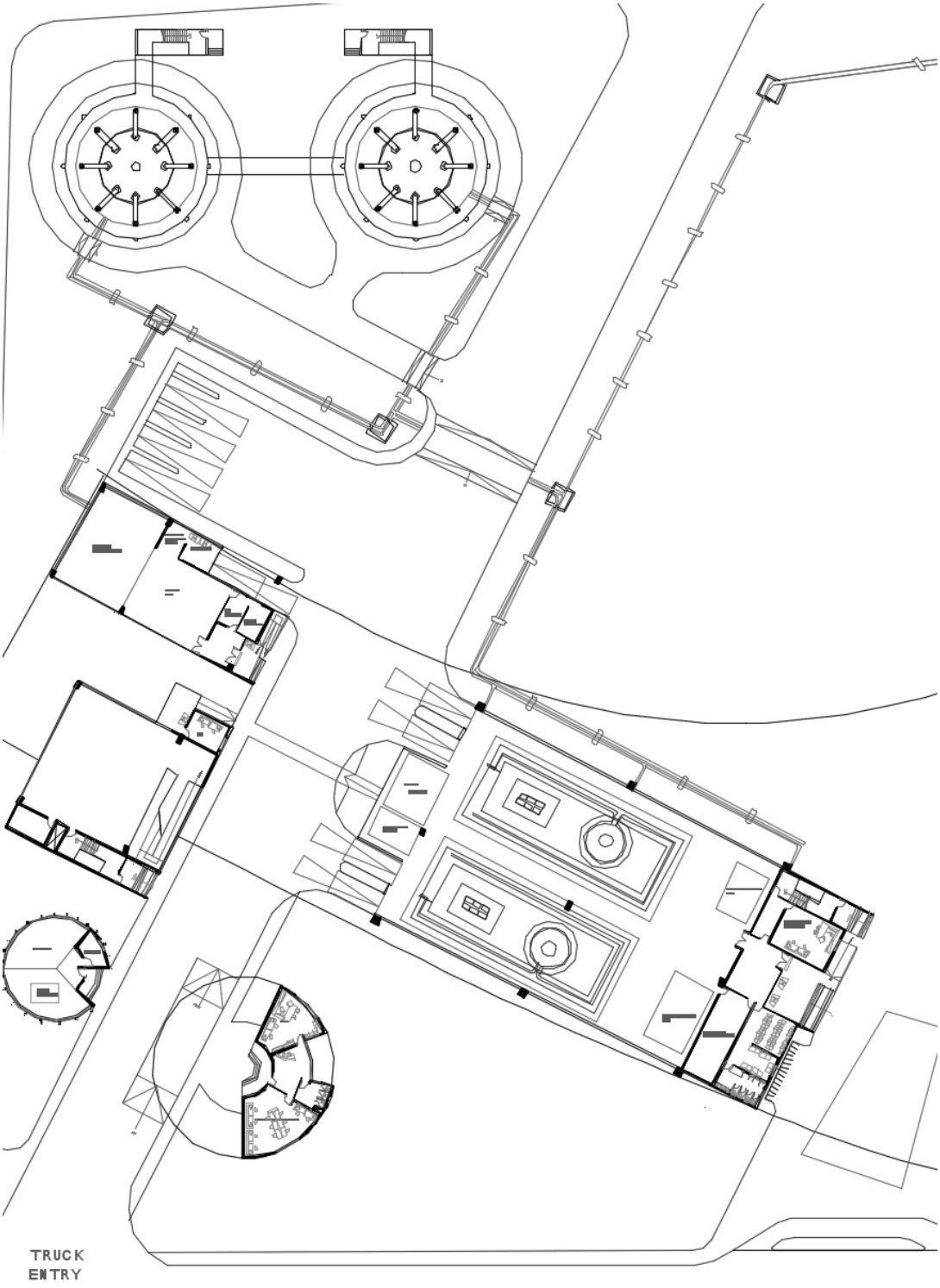

FIRST FLOOR PLAN
scale 1/32"=1'0"


SECOND FLOOR PLAN
scale: 1/32"=1'0"

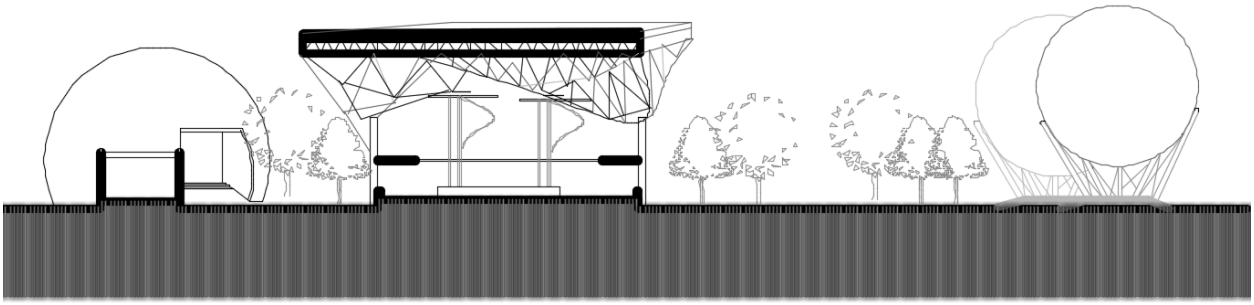

N
THIRD FLOOR PLAN
scale: 1/32"=1'0"

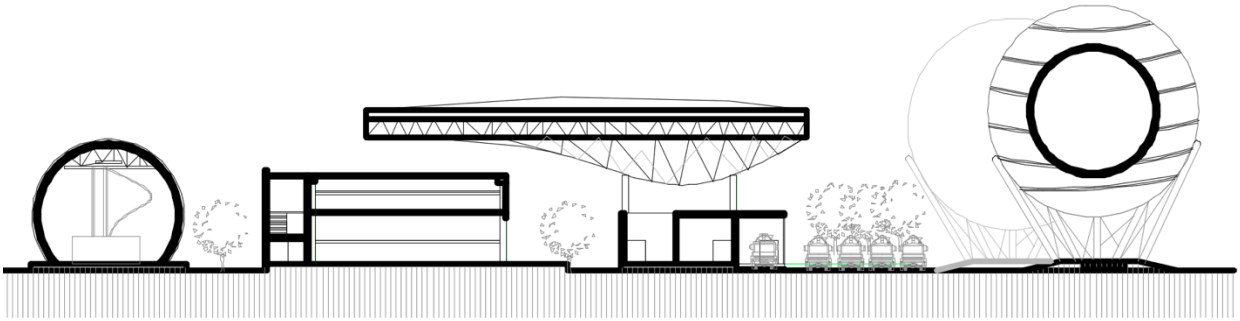

N
THIRD FLOOR PLAN
scale: 1/32"=1'0"

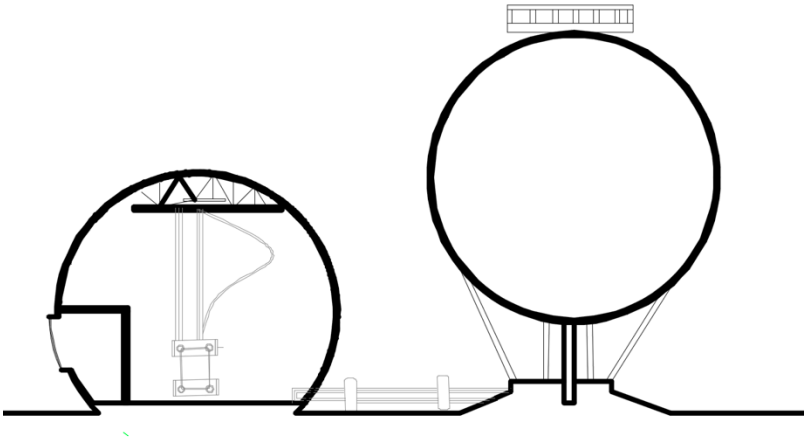
BLOW UP OF THE INDUSTRIAL ZONE



5.3: Sections

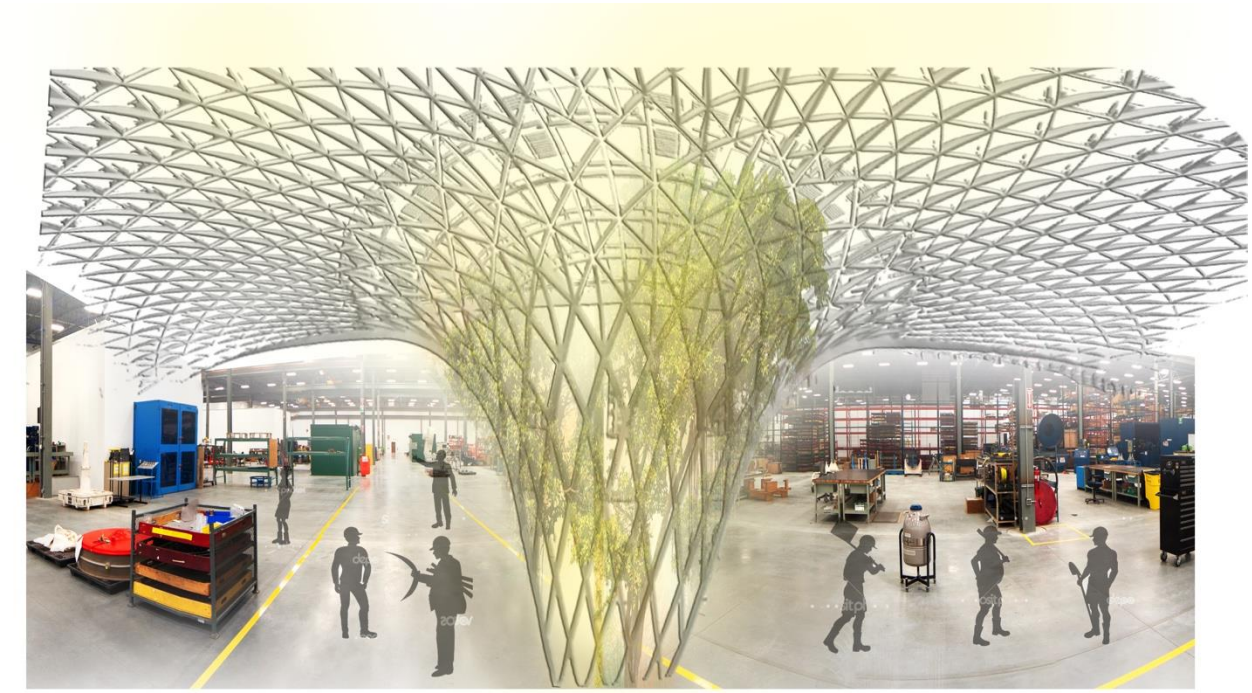


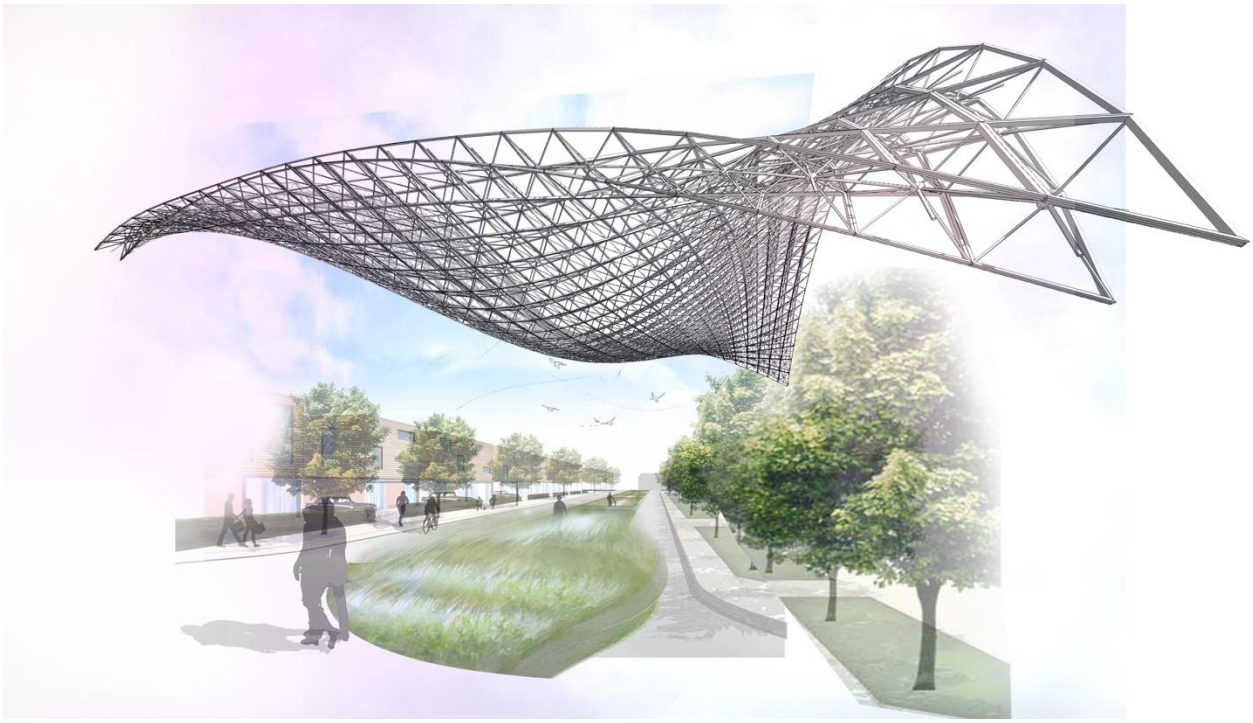


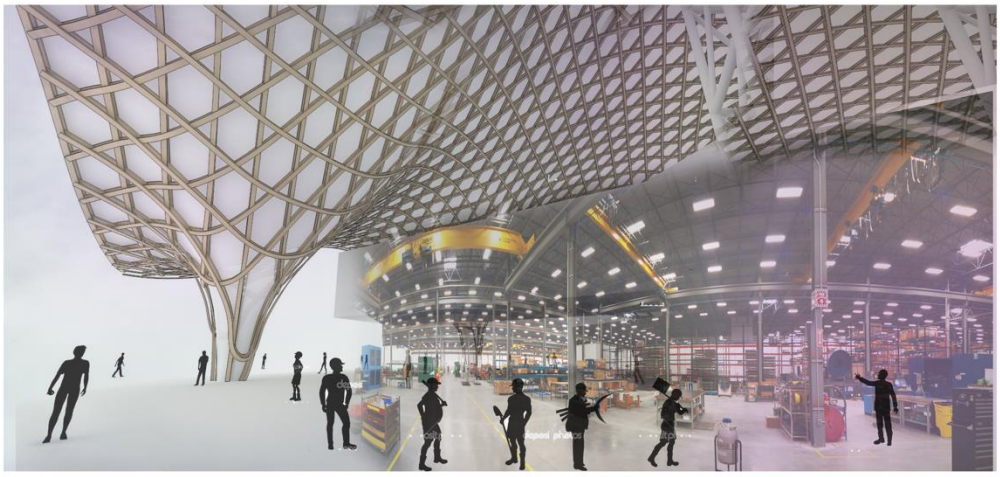



SECTION AA”
SECTION BB”

5.4: Montages







References:

Bazlul Khondhker, Abdur Razzaque, and Nazneen Ahmed (PDF). Exports, Employment and Working Conditions: Emerging Issues in the Post – MFARMG Industry." (Report).

Fauzia Ahmed. "The Rise of the Bangladesh Garment Industry: Globalization, Women Workers, and Voice."

http://www.cbsnews.com/news/bangladesh-factory-disaster-how-culpable-are-western- companies/

http://edition.cnn.com/2013/05/02/world/asia/bangladesh-us-tshirt/index.html

"Avoiding the fire next year". The Economist. 4 May 2013.

Paul, Ruma; Quadir, Serajul (4 May 2013). "Bangladesh urges no harsh EU measures over factory deaths". Dhaka: Reuters.

Nur, Shah Alam (1 May 2013). "Space shortages at rented houses make RMG units non- compliant". Bangladesh: Financial Express.

Quddus, Munir; Rashid, Salim (2000). Entrepreneurs and Economic Development: The Remarkable Story of Garment Exports from Bangladesh. Dhaka: The University Press Limited.

Yardley, Jim (23 August 2012). "Made in Bangladesh: Export Powerhouse Feels Pangs of Labor Strife". The New York Times (Ishwardi, Bangladesh).

Ethirajan Anbarasan (25 November 2012). "Dhaka Bangladesh clothes factory fire kills more than 100". BBC. Archived from the original on 25 November 2012. Retrieved 25 November 2012.

Farid Ahmed (25 November 2012). "At least 117 killed in fire at Bangladeshi clothing factory". CNN. Archived from the original on 25 November 2012. Retrieved 25 November 2012.

Anis Ahmed and Ruma Paul (25 November 2012). "Bangladesh's worst-ever factory blaze kills over 100". Reuters. Archived from the original on 25 November 2012. Retrieved 25 November 2012.

Greenhouse, Steven (5 December 2012). Documents Indicate Walmart Blocked Safety Push in Bangladesh. The New York Times. Retrieved April 27, 2013.

Quadir, Serajul; Paul, Ruma (9 May 2013). "Bangladesh factory fire kills 8; collapse toll tops 900". Dhaka: Reuters.