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Distributed by:

Flared Gas

Flared Gas Recovery & Utilization

PCC provides advanced closed-loop solution for Nigeria.

About PCC

Company Profile

Company Profile

- PCC was founded in 1993 and has 24 years' history. We are the immediate holding company of Tianjin University which is ranking no.1 in chemical engineering field in China. From this point PCC is a central government owned company.

Tianjin University Profile

- Tianjin University holds 51% share of PCC, the rest of share are management's.

- Tianjin University is the oldest institution of higher education in the modern history of China. Founded in 1895 as Peiyang University, Tianjin University's 121-year history is the epitome of the progress of modern Chinese higher education, embodying the indomitability of Chinese through challenging times.

Centuries-old History

Famous Characters of Tianjin University in History.

- During our long history, many notable scholars have studied in Tianjin University's halls. We have been lucky enough to see great minds from the fields of engineering, law and education walk through the gates of the university, and went out and made an impression in the world, walked such as poet Xu Zhimo, the first Chinese judge at the Court of International Justice in the Hague Wang Chonghui, and economist Ma Yinchu.

About PCC

Company Profile

■ Qualification & Honor

National Science and Technology Progress Award is awarded by the State Council to commend the companies and the people who have made outstanding contributions to science and technology.

PCC wins the National Award for Science and Technology Progress.

FRI Member

FRI is the most authoritative third-party research and test institution of mass transfer in the world. Her members are all of them are over the world and almost all well-known chemical companies or equipment manufacturers, like Shell, Mobil, BASF, Linde and other well-known companies.

FRI Membership Certificate

Pressure Vessel Qualification

Through systematic and effective quality, safety and environment management system, PCC creates a sustainable growth momentum.

ASME (American Society of Mechanical Engineers) was founded in 1880. ASME is one of the largest technology institutions in the world; the development of the industrial and manufacturing were influenced by many standard American Society of Mechanical Engineers. Now ASME has more than 600 standards in industrial and manufacturing field, these standards are widly used in hundreds of countries.

PCC has acquired ASME Certificate and U/NB Stamp

Flared Gas Recovery

Actuality in Nigeria

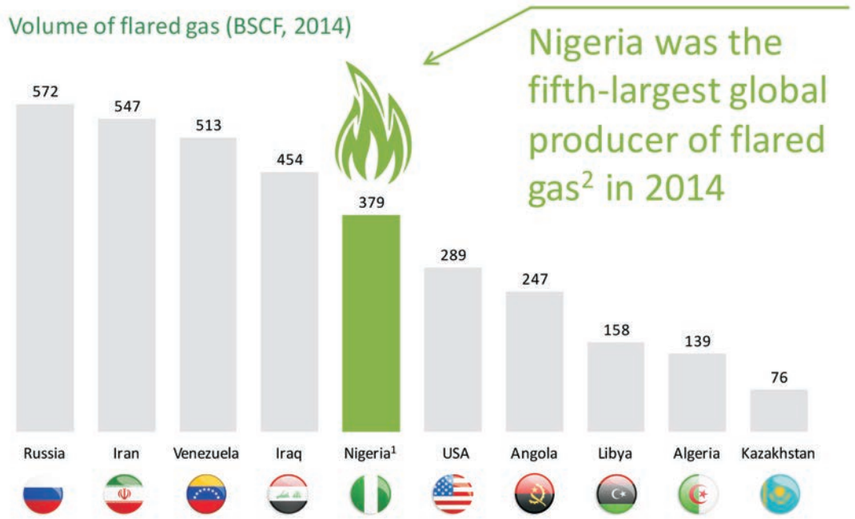
Severe Actuality

Gas Flaring

dumps harmful emissions directly into the atmosphere, with widespread environmental and health impacts on Niger Delta.

Flaring has been proven to have serious consequences for environmental health and social impacts on local communities. These include respiratory illnesses, acid rains, corrosion of roofs, amongst others. These factors, namely, the alternative social-economic uses available for flared gas, alongside the need to curb negative environmental, social and economic impacts of gas flaring; have made a national strategy for gas flare commercialisation highly needful.

Nigeria is one of the world's largest emitters of flared gas.



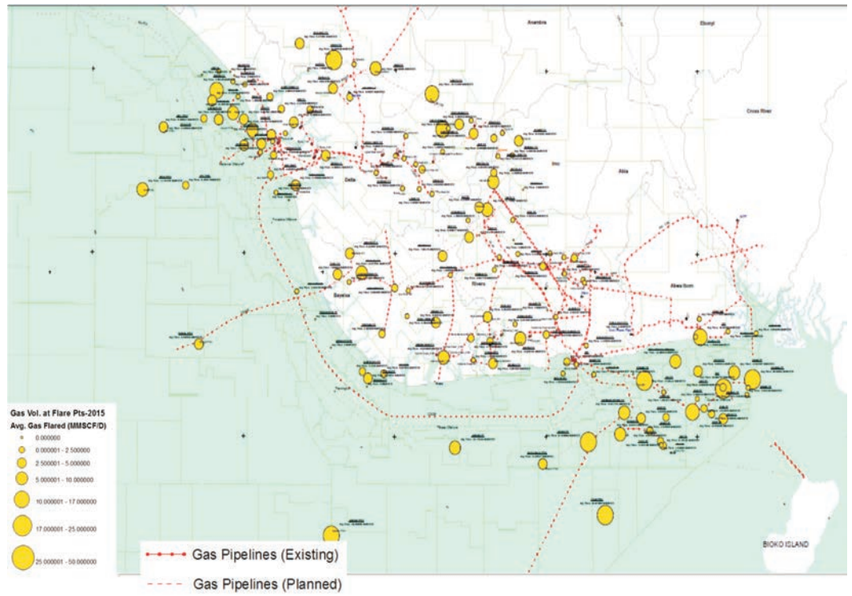
Note:
1. Two varied sources. Bottom-up field by field = 335,000MMSCF;top-downofficially reported number = 379,000MMSCF
2. EIA reports2014 Nigeria ranked 5th, GGFR reportsNigeriaranked 7th globallyin 2015
SOURCE: Cedigaz, DPR

Flaring over 370 billion scf of gas in 2014 alone, Nigeria ranked fifth in the world in gas flaring, after Russia, Iran, Venezuela and Iraq, in that order. The same year, the volume of gas flared in the country was more than gas used for any single form of domestic consumption.

Flared Gas Recovery

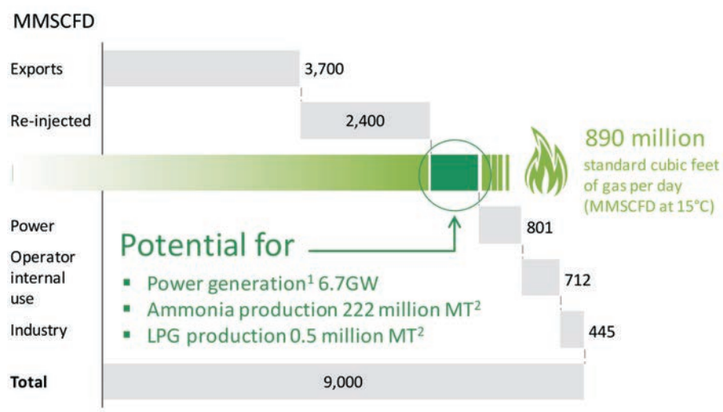
Actuality in Nigeria

Significant gas flaring is widespread-both onshore and offshore.



As a part of the Federal Government's Seven Big Wins – an array of 7 broad goals for optimising the Nigerian Oil and Gas sector – the Ministry of Petroleum Resources has clearly identified **"zero gas flaring by 2020"** as one of the specific targets under its Gas Revolution goals. To achieve this target the Ministry has designed a National Gas Flare Commercialisation Programme aimed at harnessing hitherto flared gas, and therefore ending gas flaring by the year 2020. Through the Programme, the government aims to deal with the challenges of processing associated gas, enhance more efficient supply and delivery of gas, and stimulate greater harnessing of gas to power.

In 2014 alone, volume of gas flared in Nigeria was more than gasused for any single form of domestic consumption



Clearly, this volume of gas flaring is significant, and is capable of powering hundreds of thousands of Nigerian homes as well as industrial areas with electricity access yearly. Apart from these alternative socio-economic resourcefulness of otherwise flared gas, flaring has been proven to have serious consequences on environmental health and social impacts in local communities. These include respiratory illnesses, acid rains, corrosion of roofs, amongst others.

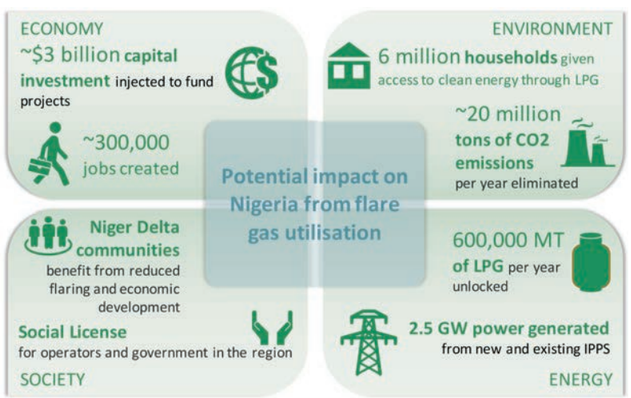
1. Assumes 50% efficiency 2. Metric tonnes
SOURCE: Department of Petroleum Resources, NNPC Monthly Petroleum Information Jan – Dec'14; Expert interviews; Energy Blueprint Memo; NLNG

Process Flow and Program

Universal Modular Flared Gas Recovery

Flared Gas Recovery System

Socio-economic benefits of the Gas Flare Commercialisation

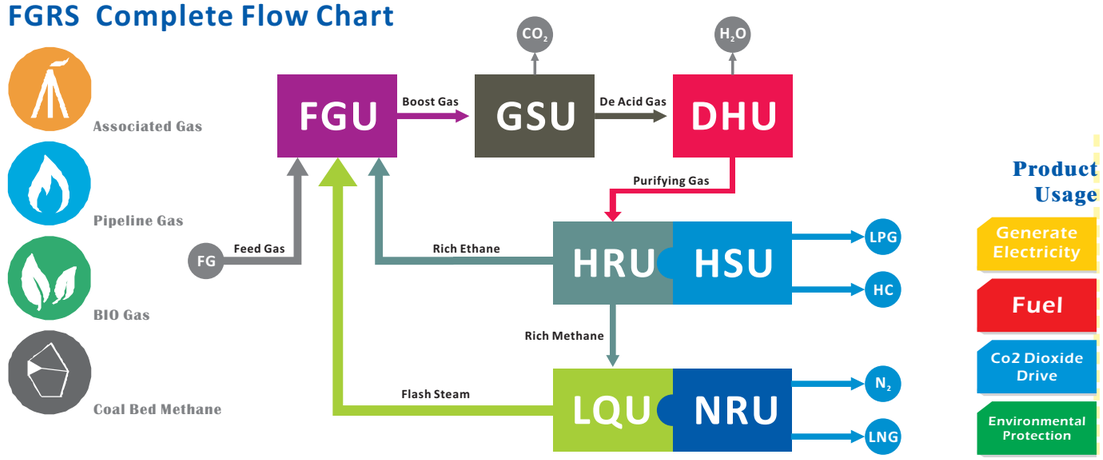


These investments pumped in to implement the gas flare commercialisation programme, huge social and economic benefits would accrue to host communities in gas-rich regions, investors and the national economy as a whole. Benefits would include curbing pollution in local communities and providing households with clean energy, particularly LPG (cooking gas), employment and jobs creation, alleviating social unrest, increased MW of electric power generation potential through gas-to-power, amongst others.

Process Flow and Program

Universal Modular Flared Gas Recovery

FGRS Complete Flow Chart



Modular FGRS Catalogue

FGRS series are F30K, F60K, F100K, F150K, covering the liquefaction capacity of 30,000Nm3/d, 60,000 Nm3/d, 100,000 Nm3/d, 150,000 Nm3/d, which will fully meet customer demand.

ITEM	F30K	F60K
Plant Capacity	30,000Nm³/d	60,000Nm³/d
Inlet Pressure	2-4barg	2-4barg
Cooling Water Rate	1608t/d	3216t/d
Thermal Oil Duty	203kW	406kW
Refrigerants Duty	238kW	476kW
Consumed Work	375kW	750kW
LNG Production Capacity	26,832Nm3/d	53,640Nm3/d
ITEM	**F100K**	**F150K**
Plant Capacity	100,000Nm³/d	150,000Nm³/d
Inlet Pressure	2-4barg	2-4barg
Cooling Water Rate	5280t/d	7880t/d
Thermal Oil Duty	667kW	995kW
Refrigerants Duty	782kW	1167kW
Consumed Work	1232kW	1782kW
LNG Production Capacity	88,099Nm3/d	131,477Nm3/d

General Introduction

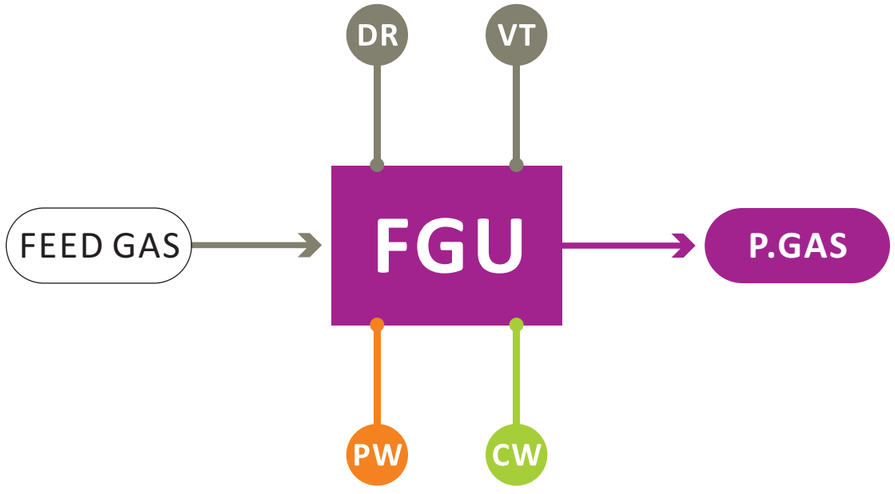
FGRS is a set of small universal modular liquefaction solution of natural gas, which adapts to a variety of gas properties, and is very fast, simple and easy to use.

1. Design Principle

Modularization is the core principle of FGRS. We divide all kinds of complete liquefaction process according to function/ process, and then form skid-mounted modules. The combination of all kinds of modules constitutes a complete liquefaction solution.
FGRS mainly contains seven units including feed gas unit (FGU), gas sweeten unit (GSU), dehydrate unit (DHU), Heavies removal unit(HRU), heavies separation unit(HSU), liquefaction unit(LQU) and nitrogen rejection unit(NRU). These units are preassembled at the manufacturing plant and can be bolted together rapidly, either individually or in clusters.

2. Modules

2.1 FGU: Feed Gas Unit



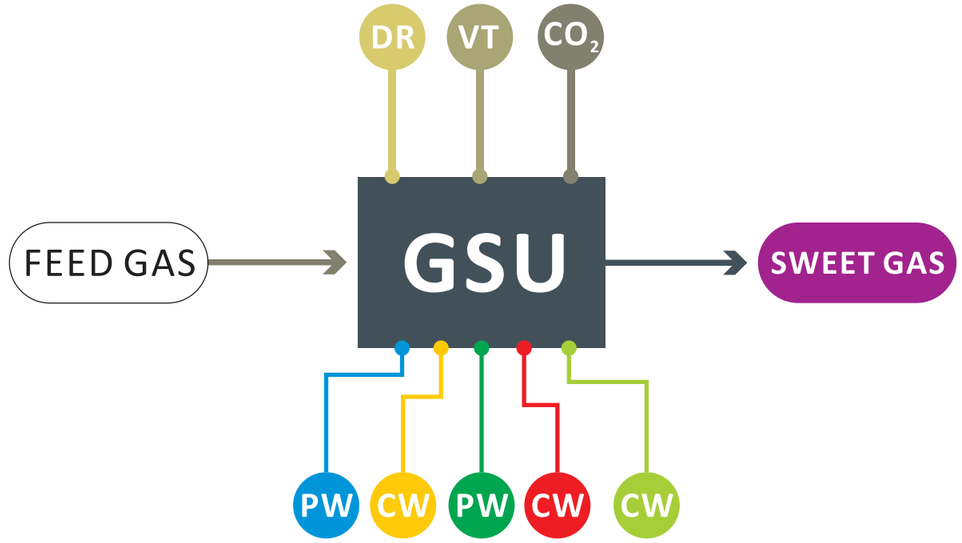
Function

Feed gas unit (FGU) is designed to achieve the function of feed gas filtering, adjusting pressure, metering flow rate, compressing and compensating. According to the different feed gas compositions, various configurations can be used.

FGU is a critical unit of FGRS. Not only feed gas but also BOG which comes from storage and delivery can be compressed in FGU.

The type of FGU compressor is usually screw compressor which has a wide range of adaptability. According to different customers demand, reciprocating compressor also can be used.
If feed gas pressure is more than 26barg, FGU can equip with a smaller compressor, which is only used to compress BOG.

2.2 GSU: Gas Sweetening Unit



Function

Gas sweetening unit (GSU) mainly removes the acidic components such as hydrogen sulfide (H2S) of carbon dioxide (CO2) from the feed gas stream. For LNG production, CO2 must be removed to a level 50ppm to avoid freezing in the liquefaction unit and H2S must be removed to meet the sales gas specification of 4ppmv.

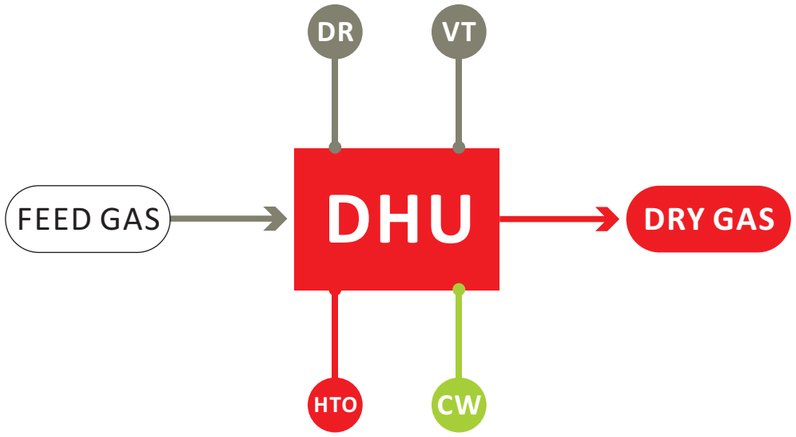
Modular Design

GSU is designed to use three different processes to remove CO2 from feed gas according to CO2 content. Molecular sieve adsorption process is used when CO2 content is less than 0.8 mol%. Amine adsorption process is used when CO2 content ranges from 0.8 to 3.0 mol%. As the CO2 content is over 3.0 mol%, muti-stage amine adsorption process is used.

INPUT	OUTPUT
FEED GAS: Feed gas contained acid gas	SWEET GAS: Treated gas without acid gas
DW: Desalted water is used to make up water	CO_2: Removal of CO_2 from feed gas
CW: Cooling water is used to cool fluids	DR: Drainage
N2: Nitrogen is used to maintain regenerated system pressure	VT: Vent
LTO: Low thermal oil is used to provide heat duty of amine regenerator.	
PW: Power is used for rotating equipment.	

2.3 DHU: Dehydrate Unit

Remove H2O in the feed, output dry gas, and control its dew point not higher than -80 ℃.



Function

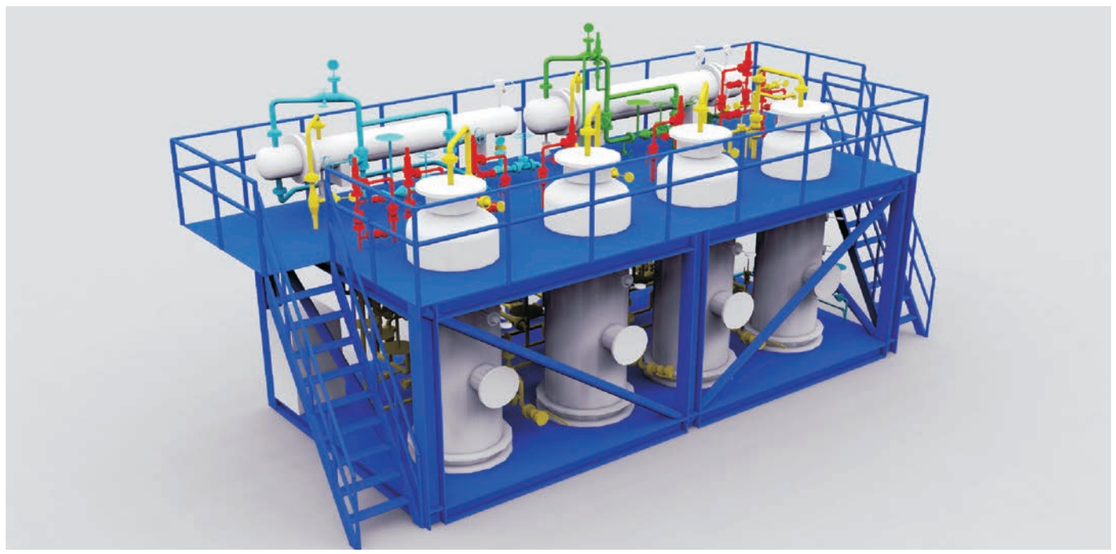
After GSU, the treating process is dehydrate unit (DHU), which is designed to meet product specification of water content. The DHU can be designed to removal water to 1ppm.

INPUT	OUTPUT
FEED GAS: Typically comes from exported gas of GSU.	DRY GAS: Gas contained water content less 1ppm.
CW: Cooling water is used to cool fluids	DR: Drainage
HTO: High thermal oil (260°C) is used to provide heat duty for stripper.	VT: Vent

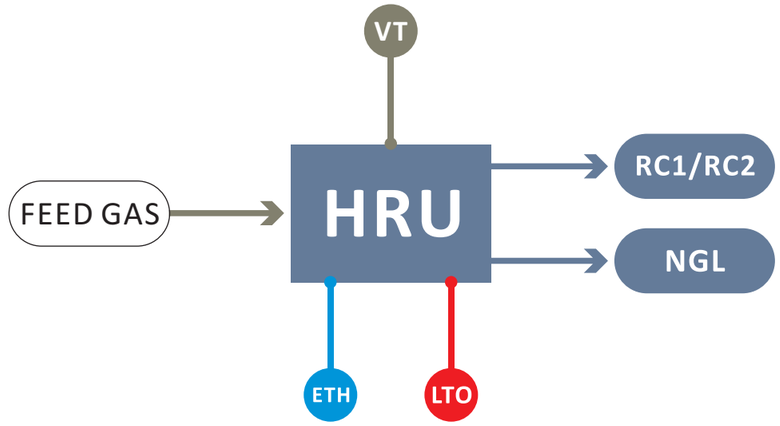
MODULAR DESING

A fixed bed of mercury removal material is installed before three fixed molecular beds in parallel lineup. The design of adsorption of water from feed gas uses temperature swing adsorption (TSA).

DHU Module Diagram



2.4 HRU: Heaviers Removal Unit



Function

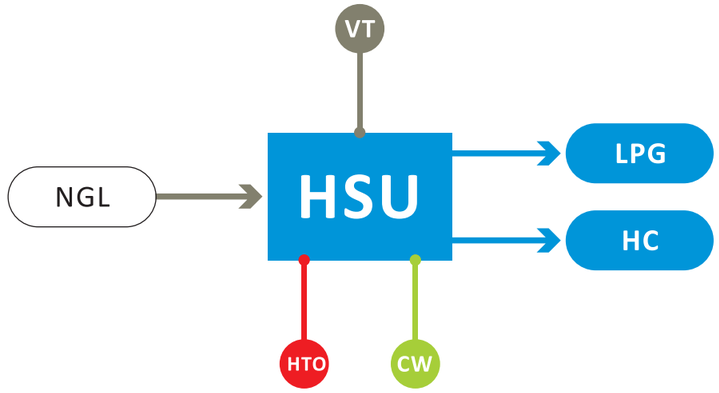
Hydrocarbon removal unit (HRU) is designed to remove C3+ hydrocarbon from feed gas. The operation of a recovery HRU is based on the deep chilling provided by vaporing ethylene to produce reflux to NGL recovery columns.

INPUT	OUTPUT
FEED: Qualified gas exported from gas treatment section.	RC1: Demethanizer overhead vapor. RC2: Deethanizer overhead vapor.
ETH: Ethylene with vaporized temperature at -80°C is used to provide condensate duty for demethanizer and deethanizer.	NGL: Natural gas liquid mainly contained C3+ hydrocarbon.
LTO: Low thermal oil is used to provide heat duty for deethanizer.	VT: Vent.

MODULAR DESIGN

HRU is designed to use three different processes including direct heat exchange (DHX) process, NGL/LNG integrated process and freezing process to remove C3+ from natural gas. HRU can be operated with or without liquefaction unit.

2.5 HSU: Heaviers Separation Unit



Function

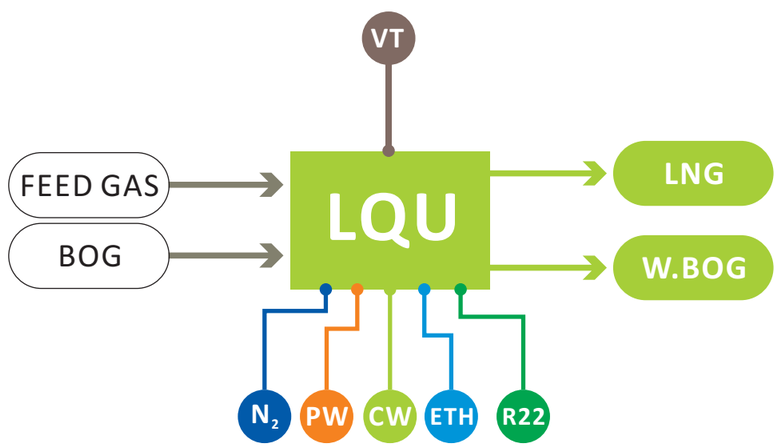
Hydrocarbon separation unit (HSU) is installed in conjunction with HRU. Once NGL has been removed from the natural gas stream, it must be fractionated into its base components, which can be sold as C3 LPG and C4+ hydrocarbon products.

FGRS™ General Introduction

Universal Modular Flared Gas Recovery

3D Module Diagram

2.6 LQU: Liquefaction Unit



FGRS™ General Introduction

Universal Modular Flared Gas Recovery

Function

Liquefaction technology is based on refrigeration cycles, which takes warm and pretreated feed gas, cools and condenses it to cryogenic temperatures into a liquid product. Refrigerants are a part of natural gas, R22 and ethylene fluids being continuously recirculated.

INPUT	
FEED : Pretreated natural gas (CO_2 = 50ppm, water = 1ppm)	BOG: Boil-off gas produced from storage and deliver of LNG
N_2: Nitrogen is used to seal cold box.	PW: Power is used for rotating equipment.
CW: Cooling water is used to cool fluids.	ETH: Ethylene with vaporized temperature at -80°C.
R22: Chlorodifuoromethane with vaporized temperature at -40°C.	
OUTPUT	
LNG: Liquid natural gas product.	W.BOG: Warm boil-off gas
VT :Vent	

Achievement of Flared Gas Recovery

COG processing capacity of 8,500MMFSCFD/a, LNG production of 3,500MMFSCFD/a.

Henan Jingbao COG to LNG Project

The project is located in Pingdingshan, Henan province. PCC is responsible for providing design and installation service based on its proprietary complete process package, including COG purification, methane synthesization, and liquefying separation technologies. By using COG to produce LNG, the project solves COG's comprehensive utilization problem and saves investment and running cost effectively for the client.

Natural Gas Liquefaction Plant Processing Capacity is 40MMFSCFD.

Processing Capacity is 1million Nm^3/d.

FGRS™ General Introduction

Achievement of Flared Gas Recovery

Main Achievement

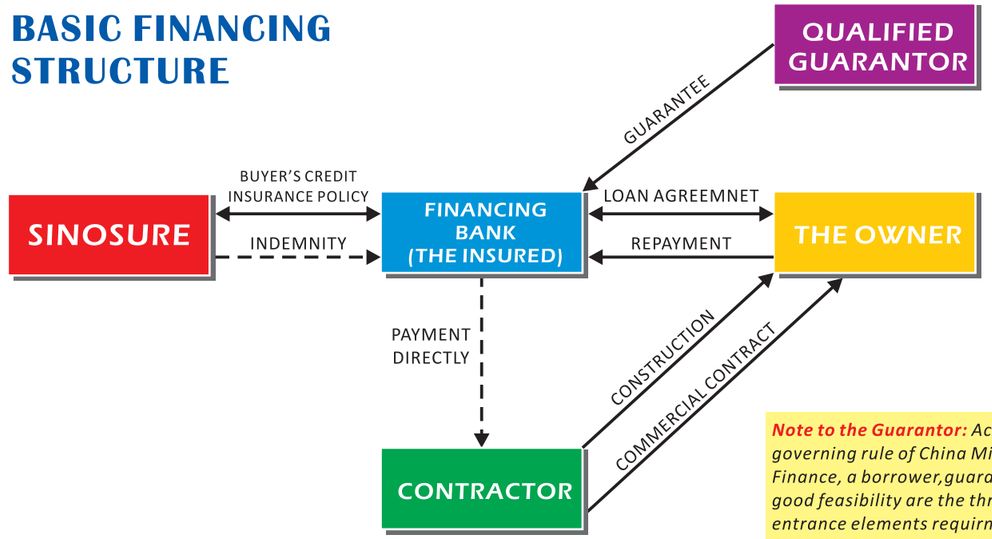
NO.	Cooperating Organization	Project	Project Scale	Contract Pattern
1	Beihai ENN Gas Co. LTD	Weizhou Island LNG Processing Plant	150,000Nm³/d	EPC
2	Shanxi Jincheng Coal Transportation Company	Coal Bed Gas Liquefaction Works	300,000Nm³/d	EP
3	Hebei Huaqi Natural Gas Co. LTD	Liquefied Natural Gas Project	1,000,000Nm³/d	EPCM
4	Shanxi Yangcheng Shuntian Coal Bed Gas Liquefaction	Coal Bed Gas Liquefaction Project (deacidification, dehydration,liquefaction, etc.)	300,000Nm³/d	EPC
5	PetroChina Huabei Oilfield Company in Renqiu City	Liquefied Natural Gas Project	100,000Nm³/d	EP
6	Luoyang Litun Pressure Regulating Station	Liquefied Natural Gas (dehydrogenation and liquefaction)	480,000Nm³/d	EPC
7	Xinneng Energy Co. LTD	LNG Cryogenic Separation Plant	1,434,7001Nm³/d	EPCM
8	ENN Langfang Development Zone Station	Natural Gas Liquefaction Unit	30,000Nm³/d	EPC
9	Zhenlai Luyuan Gas Co. Ltd.	Dehydrate & Heavies Removal Unit	100,000Nm³/d	EPC
10	Zhenlai Luyuan Gas Co. Ltd.	Heavies Removal & Separation Unit	50,000Nm³/d	EPC
11	ENN (China) investment Co. Ltd	Liquefied Natural Gas Project	100,000Nm³/d	EP
12	Hunan ENN gas storage and distribution co. LTD	Liquefied Natural Gas (dehydrogenation and liquefaction)	400,000Nm³/d	EPC
13	Henan Jingbao ENN new energy co. LTD	LNG Cryogenic Separation Plant	350,000Nm³/d	EPC
14	Tangshan iron and gas co. LTD	Natural Gas Liquefaction Unit	30,000Nm³/d	EP
15	Hegang Zheng nan coal chemical co. LTD	Dehydrate & Heavies Removal Unit	50,000Nm³/d	EPC
16	Shanxi Fuyangyuan science and trade co. LTD	Heavies Removal & Separation Unit	60,000Nm³/d	EPC
17	Shandong Yankuang international coking co. LTD	Dehydrate & Heavies Removal Unit	50,000Nm³/d	EPC
18	Chongqing Longran energy technology Co. LTD	LNG Cryogenic Separation Plant	80,000Nm³/d	EPC

FGRS™ General Introduction

Cooperation Mode

The Proposed Structure: Buyer's Credit

BASIC FINANCING STRUCTURE



Note to the Guarantor: *According to the governing rule of China Ministry of Finance, a borrower,guarantor and a good feasibility are the three basic entrance elements requirments of SINOSURE's buyer's credit.*

Main Terms & Conditions

Export Buyer's Credit Insurance Financing			
Advanced Payment	no less than 15% of the business contract amount	Interest	refer to banks
Guarantor	1. Sovereign guarantee,bank guarantee and commericial guarantee are all acceptable. 2.For commericial guarantee,the guarantor and borrower needs to meet at least 2 of the 3 following requirments:(1)Borrower:the accumulated profit is positive in recent 3 years and asset-liability ratio is below70%;(2)Guarantor:the accumulated profit is positive in recent 3 years and asset-liability ratio is below 70%;(3)the peoject will have a preferable economy performance. 3.If the guarantor's asset is at least 2 times equal to the financing amount, it will be very preferable. 4.The total guarantee amount need to fully cover the financing amount.	Premium	refer to the conditions including but not limited to the country risk, tenor, security method,etc.
		Chinese Content	for equipment export projects not below 60%;EPC not less than 35%
		Risk Covered	political risk and business risk
		Currency	USD ,EUR or other currencies acceptable to Sinosure
		Coverage (indemnity) Percentage	no more than 95% of the loan principal + interest. Banks will seek other way to cover the rest 5% risk exposure.
		Letter of Intent Fee	CNY 5,000 to be paid by the exporter
Tenor	The tenor is a mode of grace period+repayment period and in no conditions more than 15 years in total.	Letter of Interest Fee	CNY 1,000 to be paid by the exporter