



# Green River Satellite LNG Facility

## Basis of Cost Estimation

Green River LNG Facility

*Green River, Utah*  
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REVISION HISTORY					
Rev.	Date	Revision Description	Prepared	Checked	Approved
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# 1 CAPEX

DEU requested HDR to develop an Opinion of Probable Cost (OPC) for the Green River LNG Satellite Facility. The total CAPEX for the LNG plant is \$22.3 million. Table 1 below shows the costs broken down by the main plant components.

**Table 1 - Break Down of CAPEX**

CATEGORY	HDR OPC COST	
	US(\$)	Percentage of Total CAPEX
LNG Plant (LNG Storage -90,000 Net Gal, Vaporization 0.91 MMscfd)	\$ 13,243,000	59%
Land Acquisition & Development	\$ 500,000	2%
EPC Services	\$ 1,589,000	7%
Project Development and OE	\$ 550,000	5%
Contingency (20%)	\$ 2,649,000	12%
<b>TOTAL CAPEX (+/-50%)</b>	<b>\$ 22,295,000</b>	

The above table shows that LNG plant represents the highest expense which is about 59% of the total CAPEX. A closer look at the LNG plant CAPEX reveals that the LNG Storage Tank is estimated at \$1.23 million which is 6% of the total CAPEX.

## 1.1 Cost Basis, Assumptions and Exclusions

The following summarizes the methods and sources used for determining all material and labor productivity, price data, other unit rates, and factors used to calculate HDR OPC for each category as listed in the Table 1 above.

### 1.1.1 General Assumptions

The following assumptions were applied in development of the HDR's LNG satellite facility OPC estimate:

- a) HDR's OPC estimate is based on DEU's base operating requirements.
- b) The total installed cost for the LNG storage tank is based on HDR's previous experience in similar projects.
- c) HDR do not include the cost of the natural gas sendout pipeline.
- d) The total installed cost for the balance of plant items were based on a bottoms-up approach, factored cost from similar LNG projects, HDR pricing experience and factored cost for materials.
- e) Construction of the facility will be completed in a single, continuous, construction period.

- f) Construction labor rates are based on nonunion labor and have been averaged to give a composite rate for all disciplines.
- g) Project contingency cost has been set at 20% on the total installed cost, EPC services and Project Development.
- h) Cabling and raceway costs for power, controls and instrumentation are based on similar equipment on comparable projects.
- i) Cost estimates for the switchboard, throw-over system, and MCCs were based on similar equipment on comparably sized projects.
- j) Estimates of cost for SCADA, PLC and communications networks infrastructure are based on similar equipment on comparable projects.
- k) The Engineering, Procurement, and Construction (EPC) project delivery method is assumed with two primary EPC Contracts being issued: LNG Storage Tank and Balance of Plant.
- l) Mobilization and demobilization costs have been included to cover labor, materials, and equipment freight to the project site.
- m) All costs are based in 2020 dollars.
- n) EPC services are assumed to be 12% of total construction cost.
- o) Sales tax of 7% is applied to the material cost.
- p) Engineering costs are included in the HDR OPC cost estimate as follows:
  - i. Permitting and Owner Engineering services to assist DEU to further develop the project are estimated under Project Development
  - ii. Engineering fees associated with vaporization and LNG Storage Tank suppliers are included in the budgetary pricing received from the equipment suppliers.
  - iii. Detailed Engineering by the EPC contractor for the BoP after the FEED is assumed at 15% of the total construction cost.

#### 1.1.2 Labor Rate

The construction labor rate used in the OPC was developed based on the State of Utah Labor and Workforce Development current prevailing wage rates with allowances for fringe benefits, per diem, insurance, small tools and consumables, safety supplies and contractor profit and overhead. This construction nonunion labor rate is a composite rate for all disciplines and based on a 50 hour work week.

#### 1.1.3 LNG Plant

The capital cost for the LNG satellite plant item for the HDR OPC is estimated at \$13 million. Table 2 below provides a breakdown of this cost.

**Table 2 - Breakdown of LNG Plant Costs**

ITEM	LNG PLANT CATEGORIES	HDR OPC COST
		US(\$)
a	LNG Storage Tank	\$ 1,228,000
b	LNG Sendout Pumps	\$ 590,000
c	LNG S&T Vaporizers	\$ 354,000
d	NG Fires GW Heaters	\$ 218,000
e	Nitrogen System	\$ 300,000
f	BOG Ambient Heater	\$ 118,000
g	BOG Electric Trim Heater	\$ 150,000
h	Mechanical & Piping Systems	\$ 1,112,000
i	Security, Electrical, Instrumentation & Control Systems	\$ 1,928,000
j	Fire Protection Equipment	\$ 11,000
k	Structural Steel	\$ 468,000
l	Misc. Balance of Plant	\$ 2,434,000
m	Buildings (Erected Less Foundations & Electrical)	\$ 3,325,000
p	<b>LNG Plant Subtotal</b>	<b>\$ 13,243,000</b>

a. Storage Tank

The estimate for the LNG tank is based upon one horizontal ASME VIII Storage Tank each of capacity of 90,000 US gallons.

b. Vaporization

The vaporization system designed for 0.91 MMSCFD via two (n+1 100% capacity) water glycol heaters, two pumps and two shell & tube vaporizers is estimated at about \$354,000.

c. Nitrogen System

The nitrogen system includes a Liquid Nitrogen Tank and Nitrogen Ambient Vaporizer. The total installed cost for the nitrogen makeup system is \$300,000.

d. Boil-off Handling Systems

The boil-off handling systems include a BOG ambient heat exchanger and a BOG electric heater. The total installed cost is estimated at \$268,000.

e. LNG Pumps

The procurement and installation of two cryogenic sendout pumps (Ebara/Nikkiso/ACD) which includes vibration monitoring system, stainless steel pump columns and all associated electrical and controls is estimated at \$590,000.

f. Mechanical & Piping Systems

The mechanical and piping system includes the procurement of all piping, valves, fittings and pipe supports. It also includes the cost of painting, pipe insulation, construction equipment, construction indirects and scaffolding. The total estimated cost is \$1.1 million.

g. Security, Electrical, Instrumentation & Control Systems

All the labor and material costs associated for the electrical, security system, instrumentation and control systems for the balance of plant items (not included in the vendor equipment quotes) are included in this estimate. Following electrical design documents, drawings were developed in order to develop the bottoms up cost estimate. The total material cost is estimated cost at \$1.9 million.

h. Fire Protection System

The total installed cost for the fire protection system is estimated at \$11,000.

i. Structural Steel

The structural steel necessary for the pipe racks was estimated at \$468,000.

j. Miscellaneous Balance of Plant (BOP)

The total costs estimated for BOP materials is estimated at \$2.4 million. It includes the cost of the instrument air system, sump pump, emergency generator, septic system and gas chromatograph.

k. Buildings (Erected Less Foundations & Electrical)

The total costs estimated at \$286,000 million.

l. Foundations

Total costs estimated at \$1.3 million.

1.1.4 Land Acquisition & Development

The capital cost for the Land Acquisition & Development is estimated at \$500,000.

1.1.5 EPC Services

The capital cost for the EPC services is estimated at \$1.6 million.

1.1.6 Project Development and OE Services

The total cost for the project development and owner's engineer (OE) services is estimated at \$250,000.

1.1.7 Contingency

Contingency is a cost element used to account for possible increases in construction cost due to uncertainty and variability associated with cost estimating. Some cost items include limitations in project scope definition, estimating methods, estimating data, and escalations in material and labor cost when the project is bid due to economic conditions. Contingency specifically excludes changes in project scope, major events such as earthquakes, unforeseen conditions, weather delays, prolonged labor strikes, management services, etc. In general, a higher contingency is used early in a project to assist DEU with establishing a project budget. As the project progresses and actual construction cost become more certain, the contingency is reduced.

The OPC estimate for the proposed LNG storage and vaporization facility includes a 20% contingency on the total installed cost, EPC services and project development.

## 1.2 Risks and Opportunities

A formal cost risk analysis and value engineering study has not been completed, but should be considered during future project design phases to identify those cost elements that have high or very high risk or opportunity values.