Design Selection of the Cameroon LNG Project
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Cameroon: Now is the time for gas

- Cameroon’s oil production started in 1977, and has been long in decline.
- Starting in 2003, Cameroon made developing its gas industry a priority, resulting in definition of the Gas Master Plan, issued in 2006.
- The Gas Monetization Strategy led to an allocation of 3 tcf for export through a single integrated gas (LNG) project.
Cameroon hydrocarbon domain: strong, but un-exploited gas potential

- 2P commercial gas resources are now estimated to be in excess of 4 tcf, yet no operator has enough gas to anchor a major gas export project so gas fields must be aggregated to reach critical mass.

- Remaining gas exploration potential is significant: ~20 tcf (1)

- Numerous un-drilled gas prospects have been identified, both in the Rio del Rey and in the Douala basins.

- Relatively new plays in Cameroon, such as the Cretaceous, are deemed very prospective.

(1) estimate by SNH, Cameroon “National Hydrocarbons Corporation”
A strategic partnership between SNH and GDF SUEZ

In 2008 SNH selected GDF SUEZ as its strategic partner for Cameroon’s integrated gas Export Project

The objectives of the partnership are to monetize Cameroon’s gas reserves through an LNG export project while also securing LPG domestic needs, and for GDF SUEZ to secure new LNG supplies

GDF SUEZ brings its financial strength and creditworthiness, experience in developing large industrial projects and its capacity to access global long-term gas markets

SNH and GDF SUEZ have been working together through a joint project team, involving more than 40 people with diversified competencies in engineering, legal, commercial, finance and administrative support

Team is based in Yaoundé, where GDF SUEZ opened an office in 2009, and in London and Paris

H.E. Mr Paul BIYA, President of the State of Cameroon, receives GDF SUEZ management
Recent Milestones

- In December 2010, the State signed a Framework Agreement with GDF SUEZ, confirming favourable and stable fiscal, financial and commercial terms for Cameroon LNG.

- During 2012, SNH developed an attractive fiscal package for gas production tied to supply to Cameroon LNG, with incentives for gas exploration and appraisal work for supply of the LNG plant.

- In April 2012, President BIYA enacted a new Gas Code following adoption by the National Assembly, to promote the development of the gas sector and to enable the negotiation of the future Convention for Cameroon LNG.

- By end 2012, preliminary commercial agreements, or “Term Sheets” had been executed for an aggregated volumes of 3 tcf, a volume sufficient to launch the LNG project.

- At the time of writing, Kribi Power Development Company’s 216 MW gas fired power plant in Kribi, sanctioned in 2010, is expected to be commercial operation in April 2013.

Cameroon LNG is now a priority project for the State of Cameroon, part of President BIYA « Grandes Réalisations »
CAMEROON LNG PROJECT
FEASIBILITY STUDY
Dedicated Cameroon LNG Project Gas reserves

- 3 Tcf are dedicated to the LNG export project.
- All gas fields considered for the Project are offshore.
- Corresponding gas fields are spread along the shoreline.
- No operator can supply on its own enough gas for the LNG project.
- Gas resources have to be aggregated.
Project export feasibility study

The feasibility Study, in 2009, considered, for 3 LNG production capacities (1.5, 2.5 and 3.5 Mtpa):

- Four different development Options for natural gas liquefaction (LNG) facilities
- Feed gas produced from one or more different Cameroon offshore gas field Areas
- Onshore facilities located at Limbe and/or Kribi areas
The four development Options studied

Option A: Floating LNG

Option B: onshore plant

Option C: Onshore LPG & Floating LNG

Option D: separate onshore sites
The 3 Fields areas considered
Screening approach

25 cases combining capacities, development Options, gas fields Areas and site locations were reviewed and weighted based on:

- Life cycle cost - Calculation based on the estimated 2 P resources per area,
- CAPEX,
- HSE,
- Local benefit / Content,
- Project Risks.

As a result, a weighted percentage is calculated for each case.
 Screening conclusions

Best case: offshore gas fields in Area 1, with an offshore pipeline gathering system and an onshore Liquefaction plant of 3.5 Mtpa located in Kribi.

For all other gas fields Areas, an onshore Liquefaction plant in Kribi was deemed the most favourable option.

Independent LPG production plant was deemed less economic.

Floating options were less economic.
Configuration selected for next phase

- Offshore gathering pipeline
- Onshore LPG extraction and liquefaction integrated plant
- Plant located in Kribi area

Source: Wood Mackenzie's PathFinder

LPG extraction and LNG production up to 3.5 Mtpa

Gas transportation network
PreFront End Engineering and Design (preFEED)
(June 2010 – April 2011)

PRELIMINARY ENGINEERING STUDIES
Site selection

On 7 May 2010, the Cameroonian State allocated an appropriate site of 470 ha, located in the future industrial-port area of 23 500 ha.
Concept selection: Process and optimisation

**Phase 1: Screening and technology selection**
- Reference case definition,
- Screening and selection studies to fix the concept design of the infrastructures (Design Case).

**Phase 2: Engineering development including design optimisation**
- The Design Case was further developed to establish PFDs and main equipment list.
- Value Engineering reviewed at PFD level to simplify and reduce capital and operation costs. 41 ideas were identified, resulting in 20 items considered in the preFEED and 21 items to be studied at FEED phase.
- CAPEX and OPEX estimate.
Concept selection: Decision process

The main design options were studied and weighted based on the following key drivers:

– robust operation,
– minimise CAPEX,
– create value.

Each design option was assessed relative to a reference case to evaluate the impact on the above drivers.
Concept selection: results
Offshore Pipeline system

Pipeline design alternatives

10 cases studied for the same capacity, considering:

- Pipeline routing / landfall options,
- Liquids Management,
- Hydrate control,
- Corrosion control (internal).

**Best case:** Concept selected increases operational flexibility and allows a 2 phase solution.
Concept selection: results
LNG Plant

Based on:
Specific studies for:
- Construction facilities (e.g. materials offloading berth)
- Fire water (fresh water versus sea water)
- Breakwater for product jetty
- Permanent community

Proven solutions for:
- Acid Gas Removal (Unit method/solvent) and Mercury removal (adsorbent type and location)
- Liquefaction process, C3-MR but final selection during FEED phase
- Heating medium
- Marine facilities

Comparison of:

Cooling media (3 Options)
- Air coolers/ Warm/cold seawater

LPG extraction (6 Options)
- Conventional /high recovery scrub column/ Upstream NGL extraction unit and for each case possibility of integrated turbo expanders or not

Train configuration (20 Options)
- Main process drivers: Heavy/Light industrial or aeroderivative gas turbines or electrical motors fixed /variable speed
- 4 Train configurations Single/multi strings

Storages (5 Options)
- Storage capacity and Type (atmospheric, pressurised, single /double/full containment or equivalent for LPG/LNG
Summary

PREFEED RESULTS
PreFEED results: Offshore pipeline

- Pipeline system of 270 km
- Aggregation of several offshore gas fields
- 4 tie-ins
preFEED results
LNG Plant

- 1 LNG train of up to 3.5 Mtpa
- One onshore tank of 190,000 m$^3$ (full containment or equivalent)
- Two LPG tanks of 44,000 m$^3$ (full containment or equivalent)
- One Condensate tank 60,000 m$^3$ (floating roof)
- Product export jetty of 1650 m
CONCLUSIONS
Conclusions

- Technical feasibility has been established for a single two-phase gas-transmission pipeline linking all national gas resources to a single onshore plant location.

- A greenfield single-train LNG and LPG gas centre in Cameroon is viable, and Kribi is the best overall solution for Cameroon.

- A strong focus has been paid on design optimisations, proven technical choices, low CAPEX options, environmental concerns and local integration.

- Cameroon LNG Project has completed its preliminary ESIA and the first information was delivered to the public in 2012.

- A comprehensive social acceptance programme was launched involving the local community.