A MATLAB Application to Optimise and Visualise LNG Portfolio

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Agenda

- Liquefied Natural Gas
  - LNG portfolio optimisation problem
  - MathWorks developments and enhancements
What is Liquefied Natural Gas (LNG)?

- Natural gas (mostly methane)
- Cooled to -161 degrees (C) at which its main component methane liquefies
- LNG volume is around 1/600 of its volume as gas
- Stored and transported at atmospheric pressure as a boiling liquid
- Transported by large LNG tankers (typical size 145,000 to 170,000 m3)
LNG supply facilities
Global LNG trade
Boiloff is gas that evaporates from the vessel. It is either lost or can be used for propulsion

- Gas evaporates during the voyage
- Boiloff daily rate is c. 0.15% of vessel capacity (c. 240 m³ / day)
- LNG vessels can consume either HFO (heavy fuel oil) or gas for propulsion
- On natural boiloff LNG tankers can achieve 15-17kts
- At higher speeds, the operator choses to burn either HFO or gas in addition
- Deliver less than you load and this impacts the economics
LNG is priced on different oil and gas indices
Sakhalin LNG plant
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There are many flexibilities in LNG contracts

- **Timing**
  - ADP: Annual delivery programme with each counterparty
  - Arrival windows
  - Penalties for arriving outside the window

- **Volume**
  - Loaded and discharge volume flexibilities per cargo
  - Annual volume tolerances on purchase and sales contracts
  - Additional cargoes nomination at some time notice

- **Shipping**
  - Vessel choice
  - Speed and route
  - HFO versus Gas

- **Prices & Markets**
  - Destination and pricing formula
  - Sub-chartering versus LNG trading
Constraints and restrictions

- Dates
- Quality and quantity restrictions
- Geographical restrictions
- Route restrictions (Suez/Panama)
- Vessel restrictions
- Terminal restrictions
- Weather restrictions
- Cooldown availability at load terminal
LNG portfolio optimisation solution

Given a set of loadings, discharges, vessels available, the optimal LNG portfolio is defined as the most profitable allocation and use of vessels under physical constraints.

Tested applications
- Bidding
- Scheduling
- Vessel utilisation
- Sub-chartering
- Contract evaluation
- ADP scheduling

Characteristics
- Unique optimal solution
- Extremely efficient
- Scalable
- In-house development
- Compatible with other internal systems
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Solution design in the past

- Assumptions DB
- Prices DB
- Trading & Risk Management DB

Requirements

- Move to a Database solution to reduce errors associated with XLS
- Create a GUI for data inputs, portfolio visualisation and analysis of results
- Integrate with other systems and DB
- Be able to scale efficiently

Static inputs
Prices inputs
Portfolio inputs
Outputs table
Moving Portfolios from Excel to SQL Database

Existing portfolios

Save

Read

Data

Access

Layer

Portfolio database

Read

Save

Portfolio Model

Supply Windows

Supply Port

RUSSELL Perú

NGERIA Bonny Island

HINDONESIA Batang

Jul 2015

Jan 2016

Jan 2015

Optimisation Code
Interactive Data Editing & Visualization
Scaling Portfolio Optimisation

MATLAB
Distributed Computing Server

Parallel Computing Toolbox
Questions?