KYOS Webinar
3 November 2020
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Pricing and hedging of LNG structures

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Agenda

15:00 – **Introduction**

15:05 – **Trends in the LNG market**

- From oil to gas price indexation
- Trends in regional price spreads

15:20 – **LNG portfolio valuation**

- Flexibility along the LNG supply chain in sourcing, liquefaction, transport and storage
- Valuing the LNG flexibility and monetizing the value

15:35 – **Q&A**

15:45 – **End**

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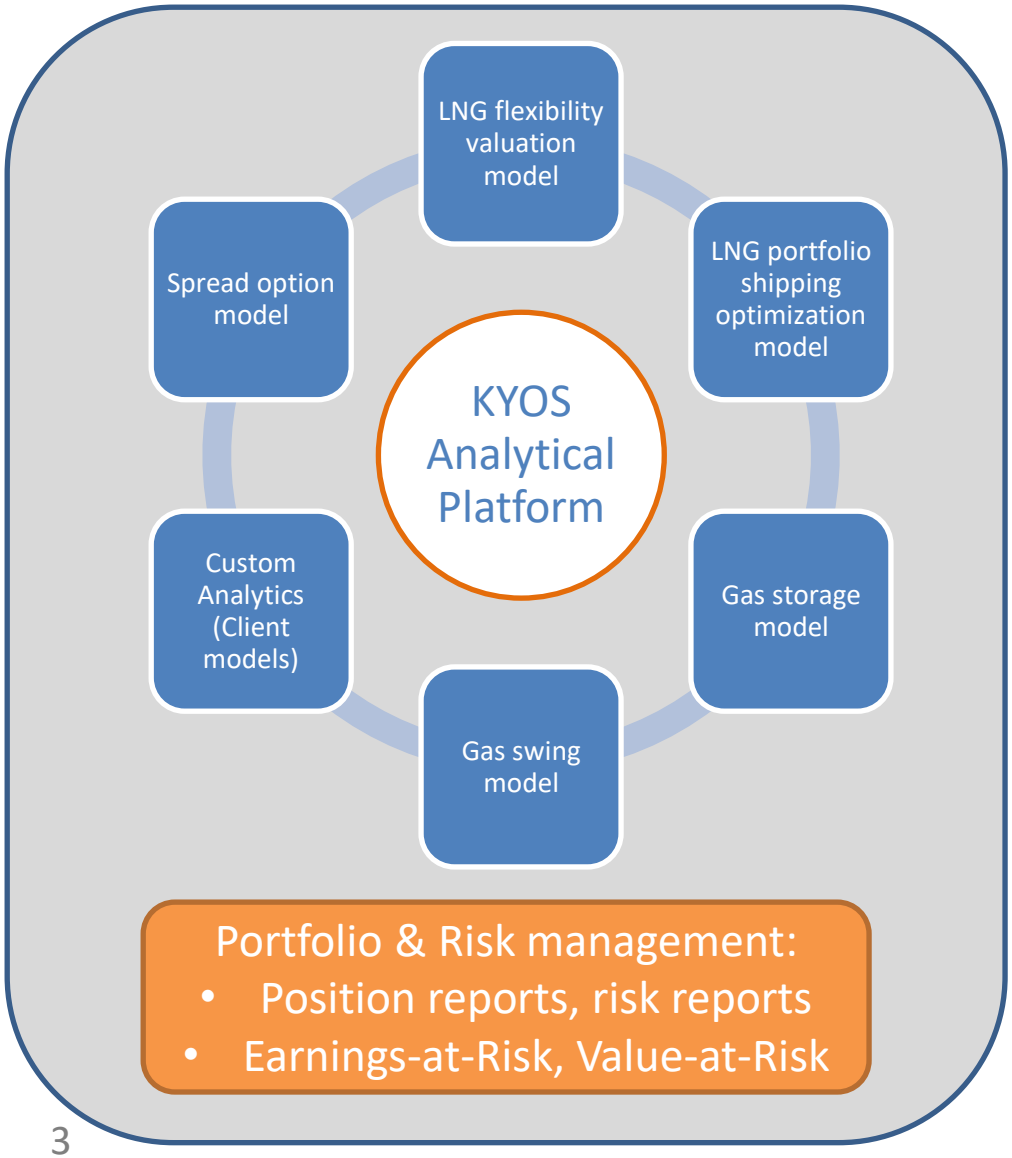
KYOS Analytical Platform



Web-based system

- Market data interfaces
- APIs
- Automated workflows
- Monte Carlo
- Flexible reporting

For the portfolio and risk management of all your LNG and natural gas trading activities.

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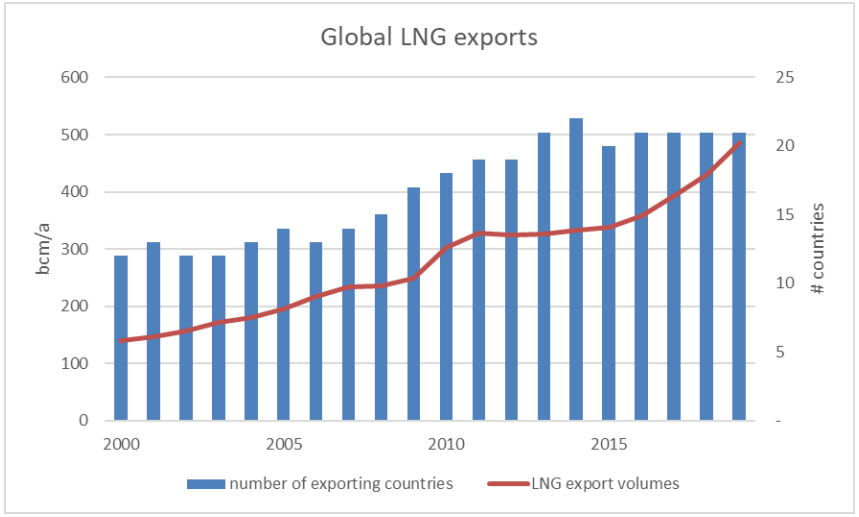
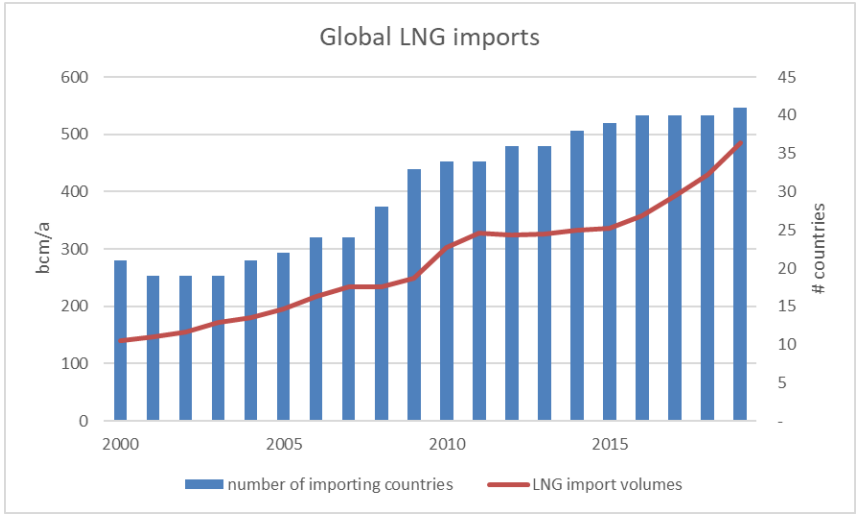
Part 1:
From oil to gas price indexation

General trends in global LNG

Globalisation of LNG markets continues





- Exporting countries: 20
- Importing countries: 40
- Total LNG fleet: 550

Several more import and export terminals being constructed/planned and LNG fleet growing further

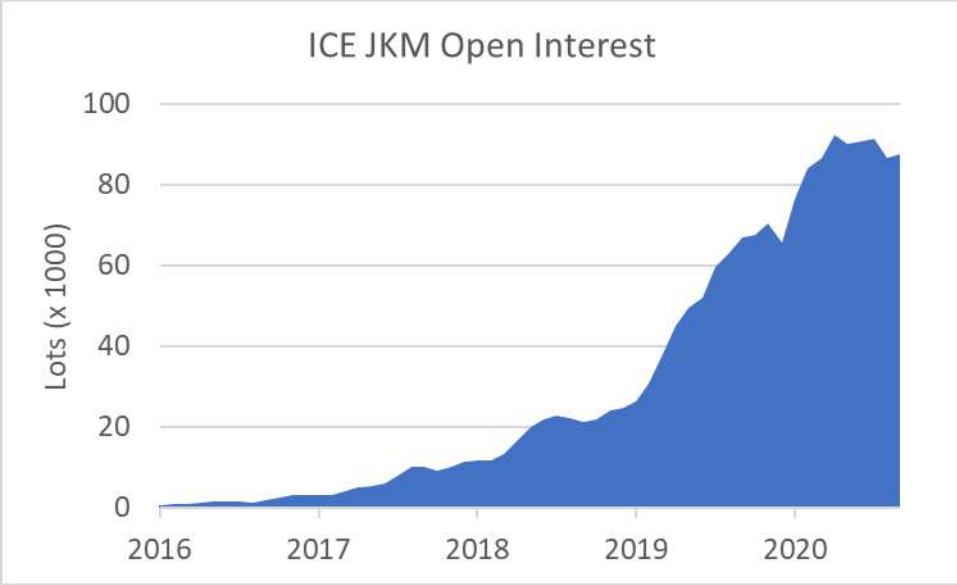
General trends in global LNG

Globalisation of LNG pricing continues as well

- Over 50% of global LNG supply is currently gas indexed
- TTF and HH largely uncoupled from oil
- Japan LNG prices appears to be decoupled since 2019 and closely following TTF

LNG in Asia

- 30% of LNG imports sold on hub-index basis in 2019 (IGU survey)
- Trading in JKM contracts strongly increasing



- About one third of Chinese LNG imports in H1 2020 was spot based.
- Spot LNG important driver of Japanese electricity spot prices
- Even with Covid, 2020 YtD Asian LNG demand stronger than 2019
  - China lowering pipeline imports
  - Additional consumption in Indian power sector

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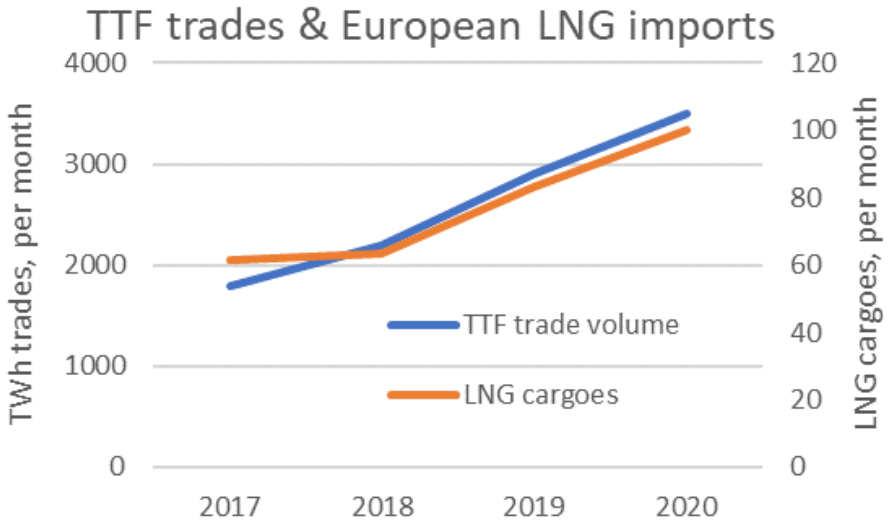
LNG in Europe

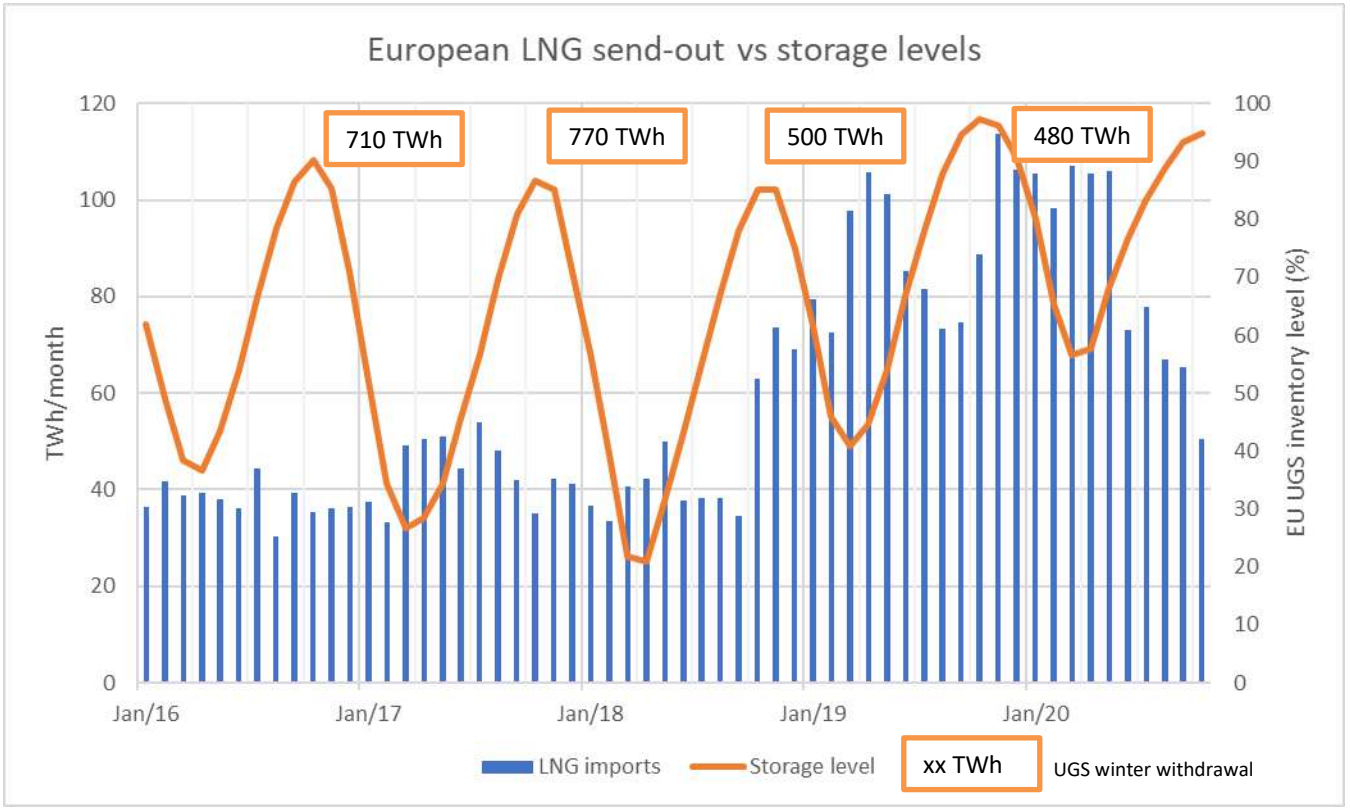
- 68% of LNG imports sold on hub-index basis in 2019 (IGU survey)
- 47% of LNG imports to southern Europe still some oil-indexation



- In Northwest Europe hub indexation is 100%
  - E.g. TTF – discount for regas and transport
  - Flexible contracts with full diversion rights
- LNG had around 25% share in European supply in 2020
- Market players use depth of NBP and especially TTF market to manage their risks: more LNG imports, more TTF trading

EU LNG imports and underground gas storage

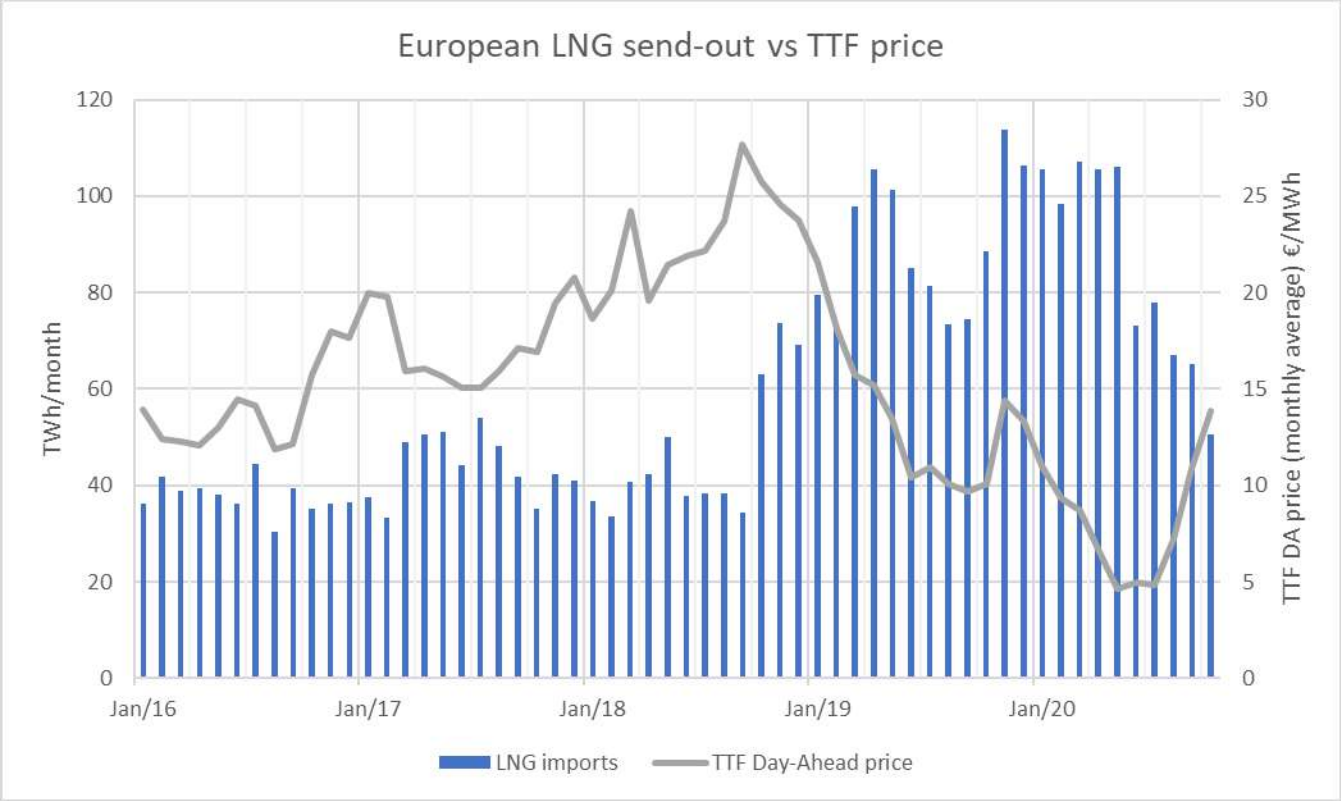
- Europe important as flexible demand center for global LNG
- Large underground storage (UGS) position: >1,000 TWh
- LNG imports were important driver of utilization storages
- High EU LNG imports over last 2 winters replaced storage withdrawals



Source: ALSI/AGSI

EU LNG imports and underground gas storage

- LNG imports also influenced TTF price level
- High summer LNG imports led to depressed TTF price level



Important for EU players to be active in the LNG market and global LNG players to become active in EU gas market including storage

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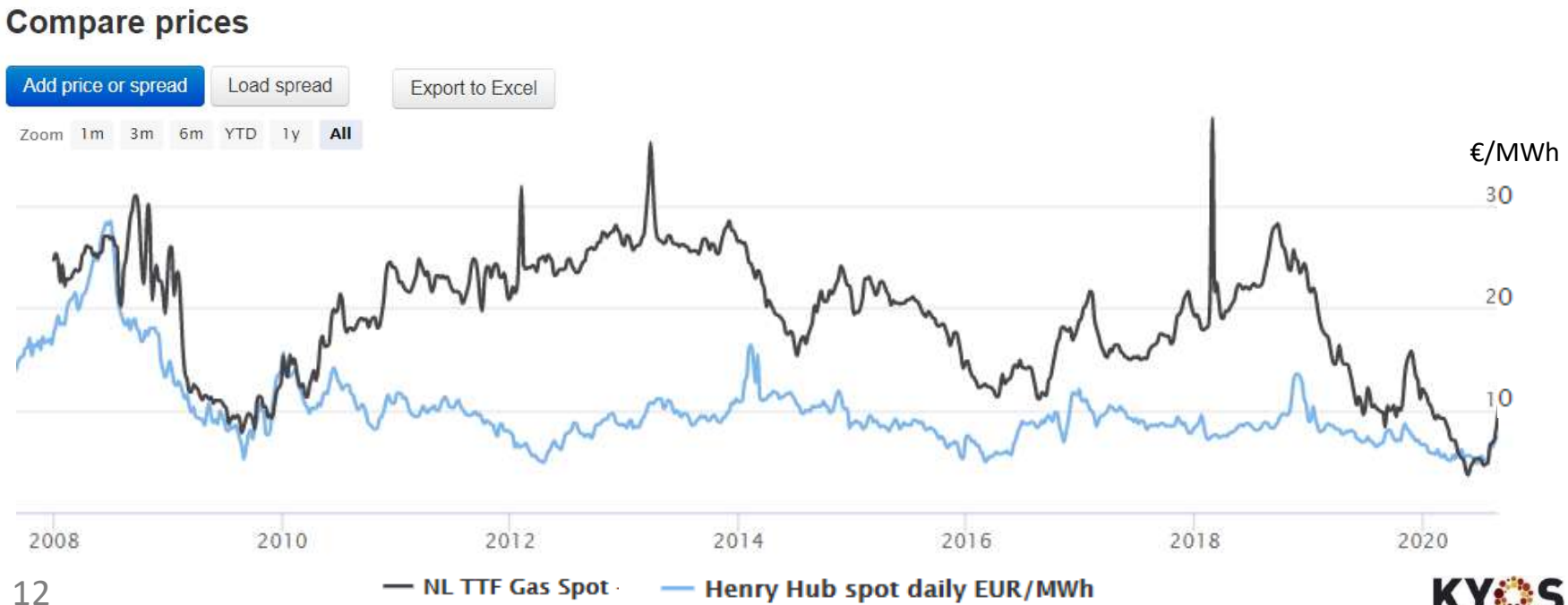
Part 2:
Trends in regional price spreads

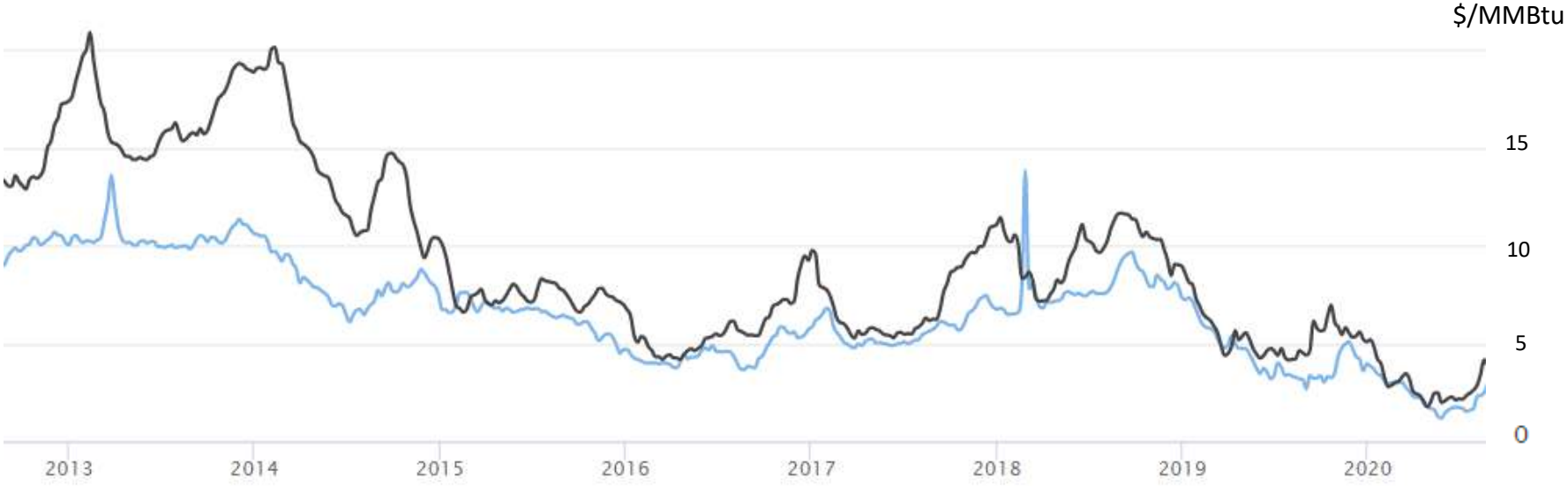
US versus Europe: Henry Hub and TTF

- 2000-2008, US natural gas was at around 5 $/MMBtu or 15 €/MWh
- From 2008, US natural gas lost around 50% of its value
- Until mid 2020, TTF was well above Henry Hub (in €/MWh)

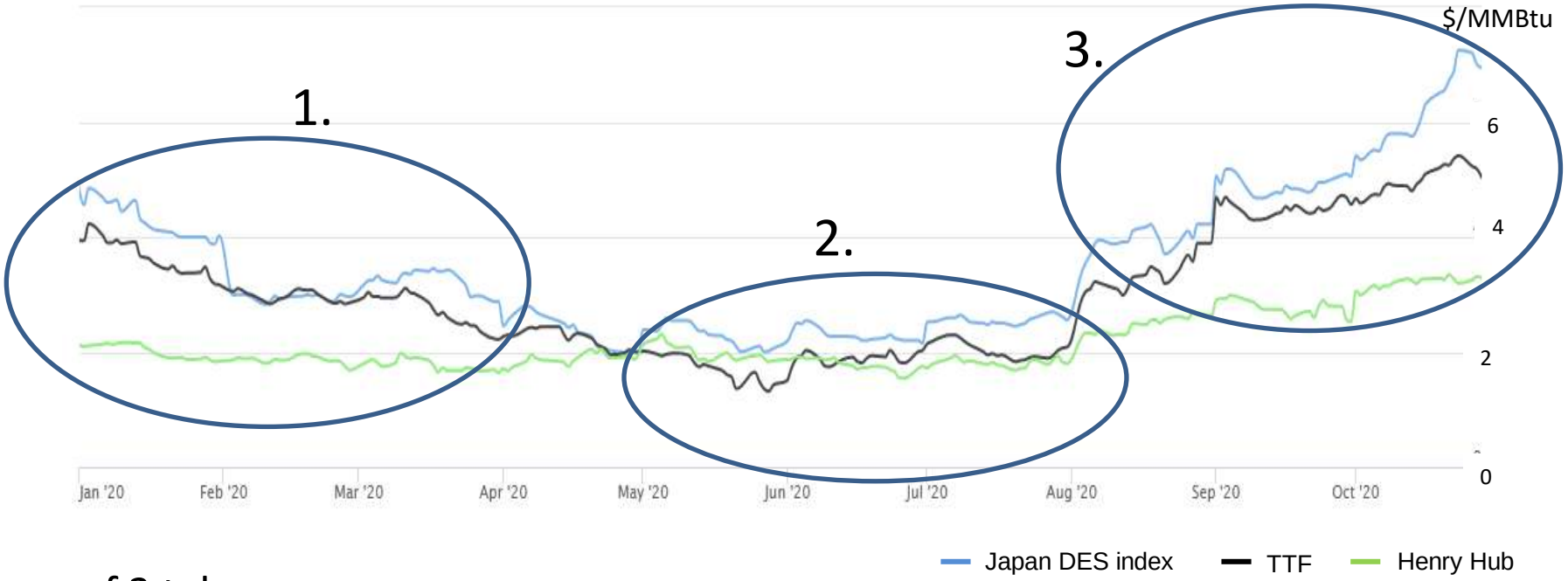


EU versus Asia: TTF and Japan import

- TTF – Japan price gap has narrowed since 2015
- Strong price correlation, except for “cold European winters”
- Flexibility to divert cargoes from Asia to Europe or vice versa has become ever more important
- This option was far out-of-the-money in 2013-2014, but more at-the-money and hence valuable in the past 6 years



Closer look at 2020

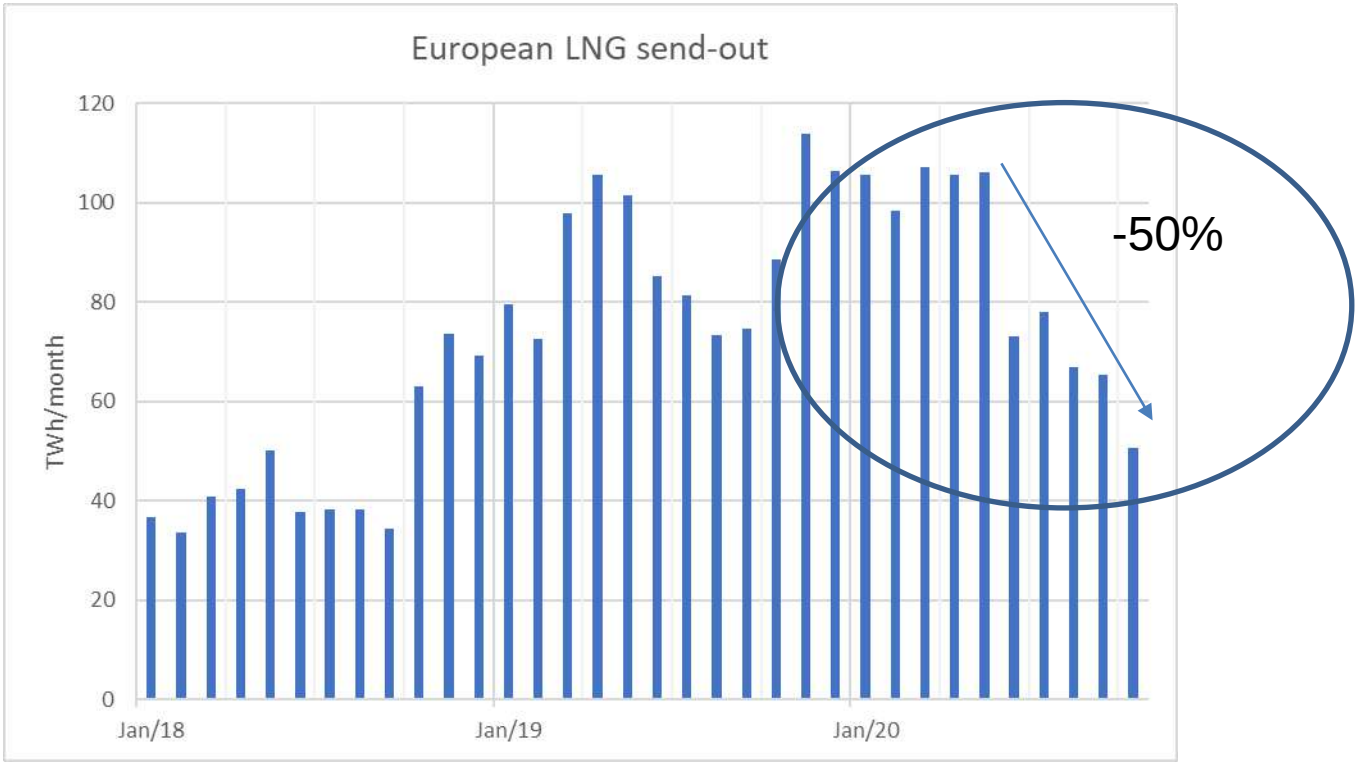


Story of 3 tales

1. TTF and JKM well above HH. TTF/JKM spread small enough to send US cargoes to Europe
2. Low prices at TTF and JKM compared to HH. Making US exports non-economical: many cargo cancellations
3. Arbitrage opening over last few months. Strong Asian demand led to increase in JKM, dragging up TTF. TTF increase not enough to attract cargoes

Closer look at 2020

1. Decrease of TTF x HH led to strong decrease in LNG arrivals in Europe over 2020.
2. The recent increase of TTF was not enough to attract more LNG.



Source: ALSI

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Part 3:
Portfolio optimization - example

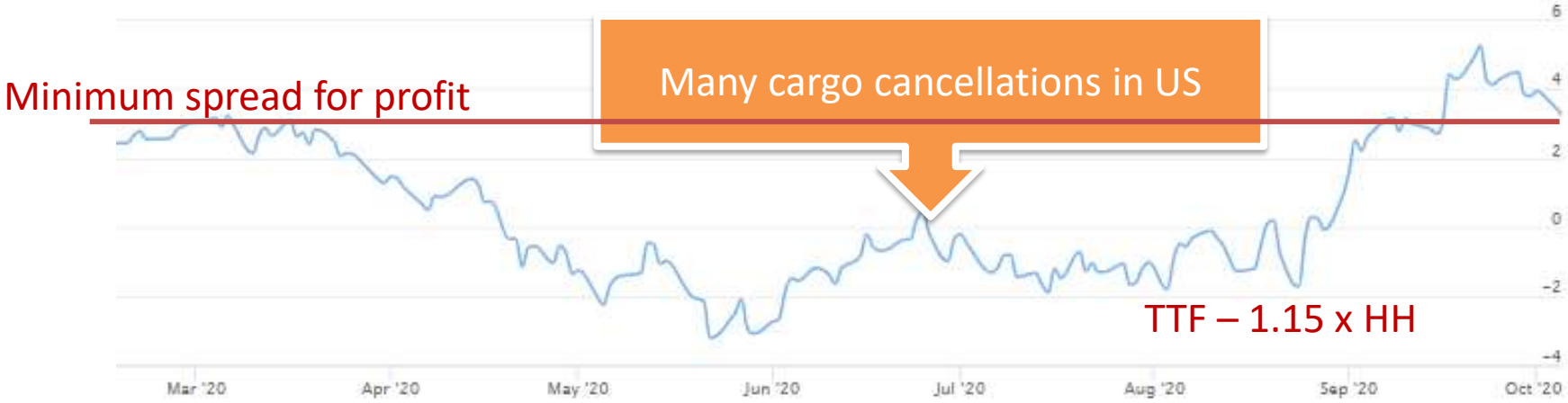
Example supply chain: US to Europe/Asia

1. Different sourcing and transportation options to Gulf coast
2. Use liquefaction or cancel and sell pipeline gas in the US
3. Ship LNG to Europe or to Asia
4. Selection of vessel type and shipping route (Asia mainly), maybe even of floating storage
5. Selection of exact gasification terminal in the area

US sourcing and liquefaction

1 2

- Cheniere concept of tolling deals in liquefaction:
  - First contract in 2016 with BG/Shell at 115% x HH + $2.25
  - Many similar tolling deals followed, with premiums of $2-3.5
  - More recently also tolling deals with other indexations
- Clients need to recover fixed fee + transport costs
- Clients may cancel deliveries: about 180 cargoes in Apr-Sept ‘20



US liquefaction option with Take-or-Pay

- Take-or-Pay conditions are to guarantee minimum income for liquefaction operators, e.g. minimum of 50% utilization
- This can be valued as a swing contract with delivery TTF and indexation to Henry Hub, e.g. using monthly rolling intrinsic trading strategy and Monte Carlo simulations
- Some inputs to the valuation:

Volumetric constraints

Gas year

Start	Min (MWh)	Max (MWh)
2020-10-01	4927500	9855000
2021-10-01	4927500	9855000
2022-10-01	4927500	9855000

Pricing against TTF

Index product — Forward curve

Product: Month | Maturity: 1 | Henry Hub FWD Curve [310]

Settlement price: 1.15 / 0.293071 | Weight

Henry Hub futures [195] | 3.924

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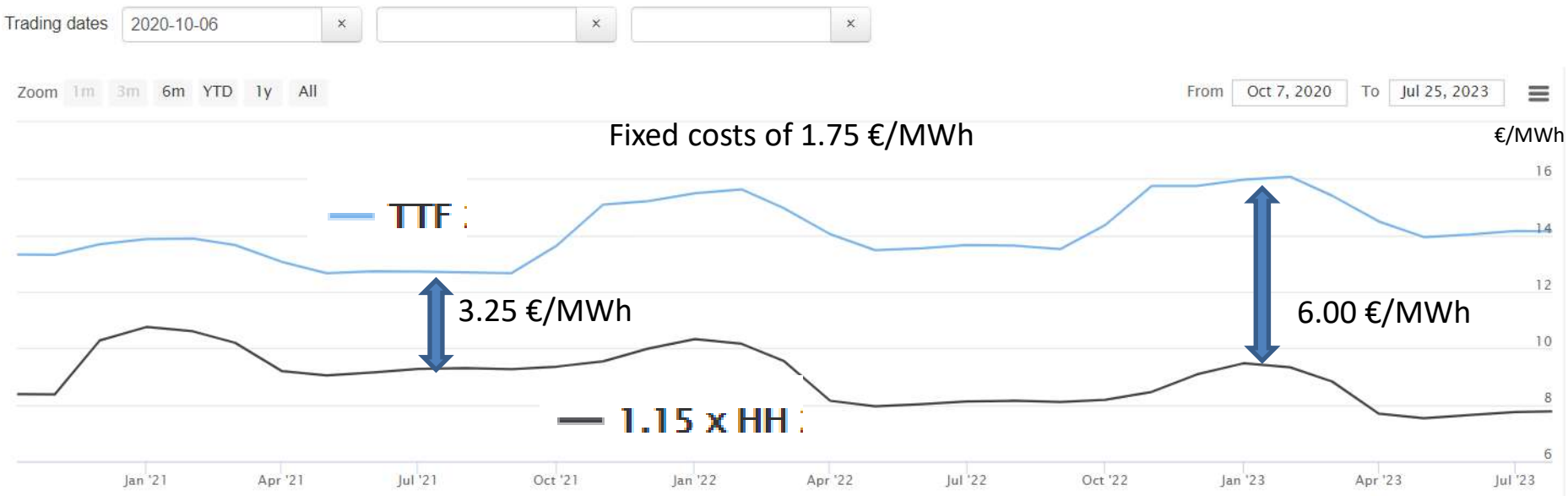
Value of liquefaction with cancellation option 2

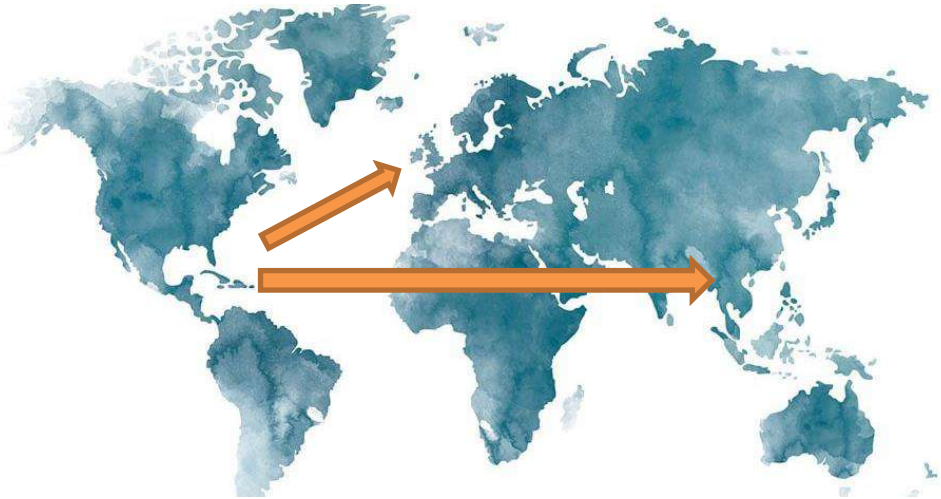
- Intrinsic value (no cancellations): € 54 mln
- Option value (intr + extrinsic): € 67 mln
- Value of option to cancel up to 50% of cargoes: € 13 mln



To Europe or to Asia?

- For the valuation of the cancellation option, we assumed highest prices in Europe (TTF)
- However, shipping to Asia may be more attractive, despite lack of liquid trading market
- Can be sold on spot basis, but beware of extra shipping costs
  - 46% of US LNG went to Europe in 1H 2020
  - 33% of global LNG trade in 2019 was spot (ICIS)

This is a diversion option, regional spread option, but only if liquefaction is not cancelled



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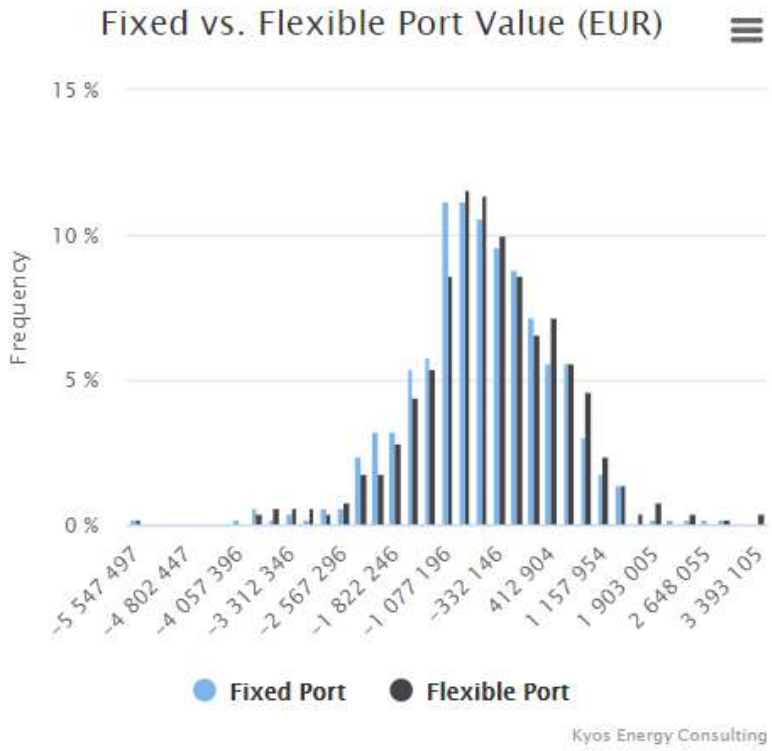
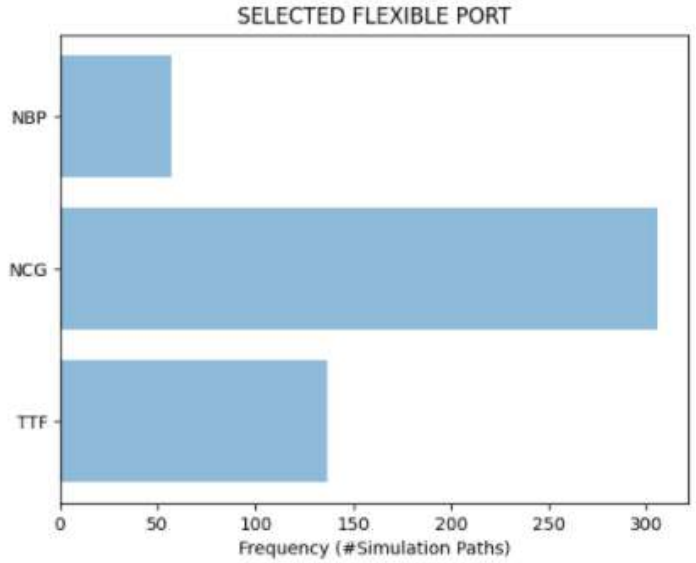
Valuation of destination flexibility

- Joint Monte Carlo price simulations of N markets
- Flexibility to choose port compared to fixed port (Gate, TTF) based on optimal decisions at different points in time





Intrinsic or delta hedging?

- In general:
  - sell TTF futures, buy HH futures
  - But when spread is too low, adjust hedges
- Rolling intrinsic hedging:
  - Lock in 100% of the spread if current margin is positive
  - Unwind the whole spread if current margin is negative
- Spot optimization and delta hedging:
  - Lock in a variable volume
  - Increase the hedge volume if spread goes up
  - Reduce the hedge volume if spread goes down

The KYOS system shows the optimal intrinsic and delta hedge volumes

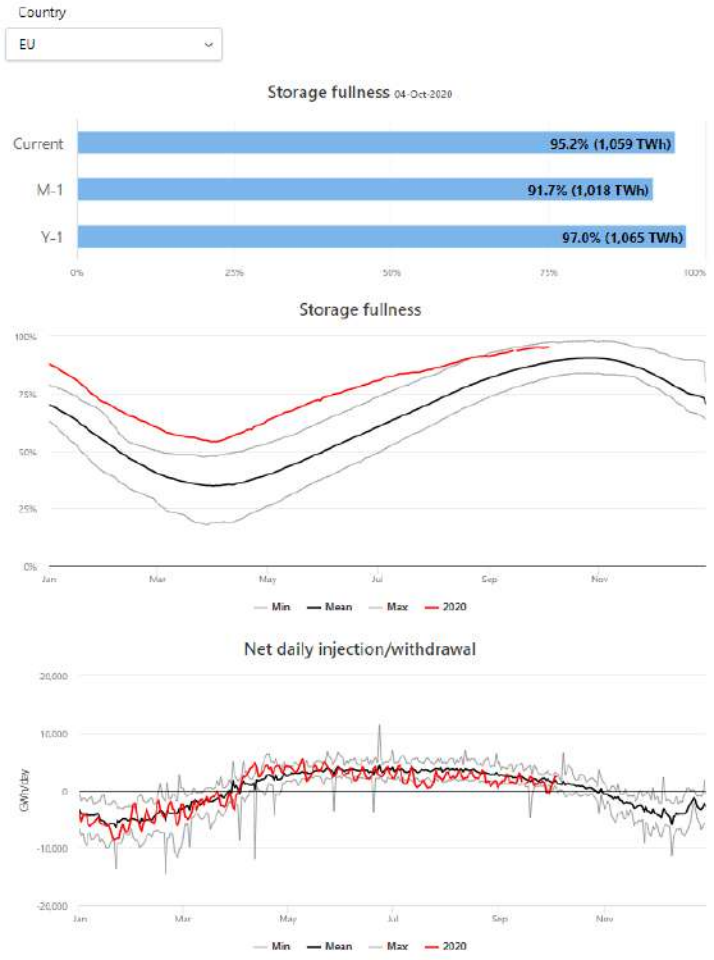
The role of storage

- Floating storage:
  - Benefit from (steep) contango in market
  - Postpone deliveries and keep option to divert
- On-shore storage:
  - Slower send-out of volumes, so less liquidity impact
  - Underground storage as buffer for LNG flows comes with a cost, directly (storage lease) or indirectly (opportunity cost)

Gas.kyos.com: all about storage of (L)NG in Europe

KYOS European Gas Analytics

Home | Explore UGS data | Explore LNG data | Auctions



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Part 4:
LNG portfolio management

LNG portfolio management

LNG portfolio management has different dimensions

	Portfolio optimization	Short-term optimization (<1 yr)
Main elements	• Mid- and long-term contracts • Liquefaction/regas bookings • Shipping capacity bookings • Gas storage bookings • M&A deals	• Exercise flexibility options • Optimize cargoes • Trade spot LNG and nat gas
Main analytical competence	• Option/flex valuation • Hedging • Risk management	• Logistics optimization • Spot trading • Position management

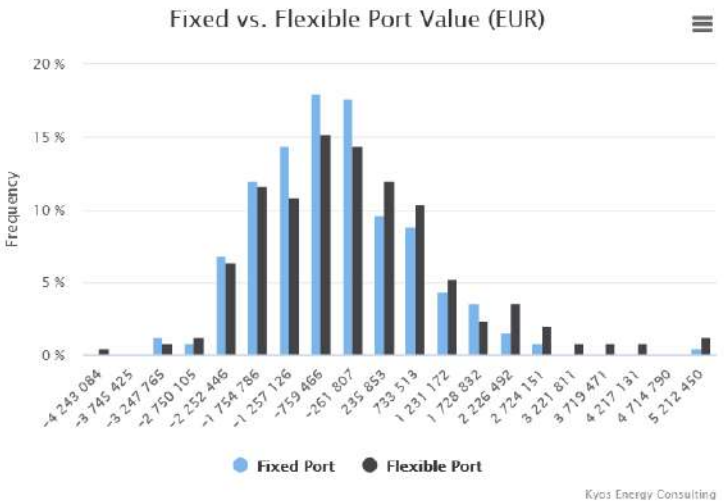
LNG portfolio optimization

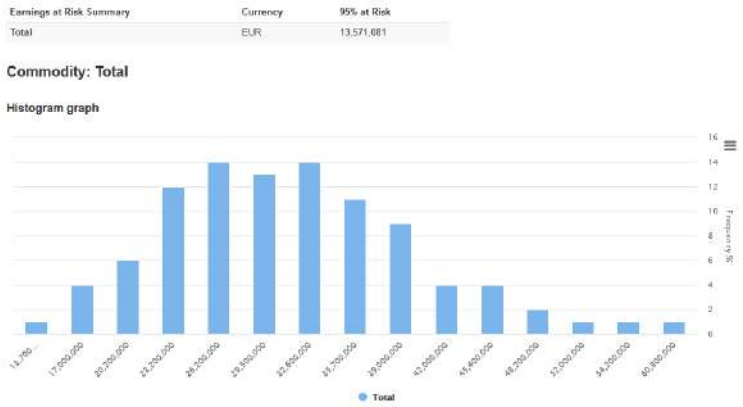
Steps:

1. Stand-alone deal valuation
   Including (embedded) optionality
   Value and risks

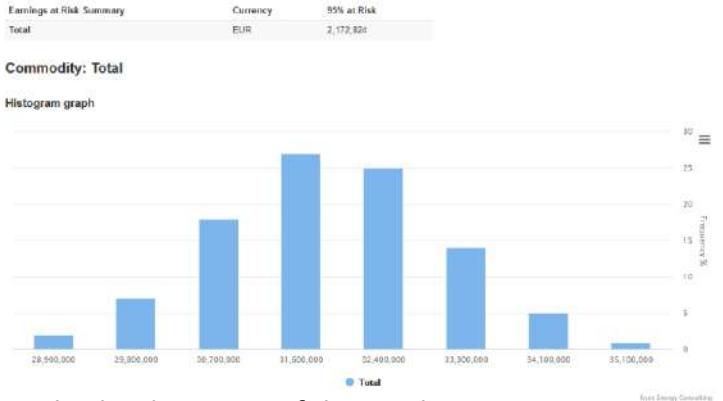
2. Integrate into overall portfolio to see effect on overall risk distribution (EaR/VaR)

3. Define and execute hedging strategy





EaR unhedged LNG portfolio: 13mln EUR



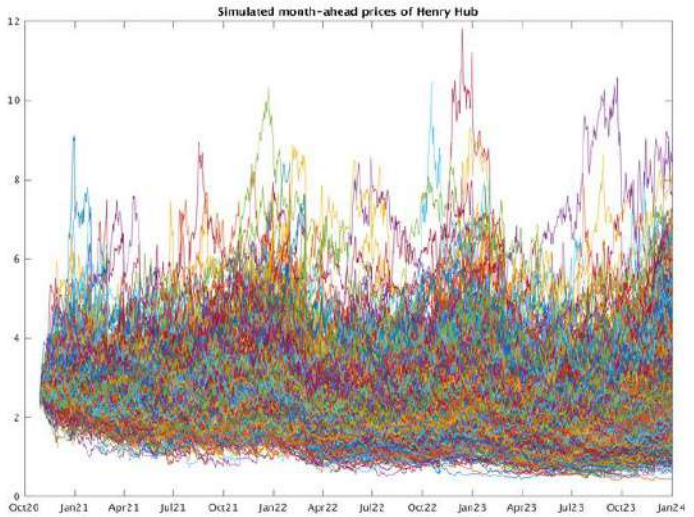
EaR hedged LNG portfolio: 2mln EUR

LNG portfolio optimization

Central building block:

Realistic Monte Carlo price simulations taking dynamics between main price indices into account.

- Calculation of optionality and flexibility in contracts
- Risk distribution of portfolio
- Important: take care of (change in) relation between TTF, HH, JKM, Oil



LNG forward hedging

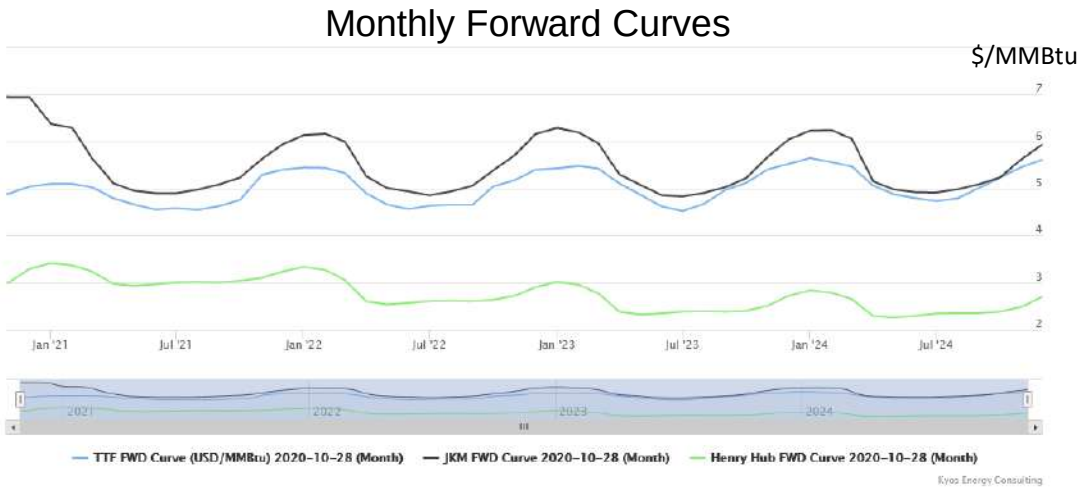
Example: supply contract from liquefaction project, priced at Henry Hub.

- Buyer has basically bought a strip of location spread options
- Buyer can deliver to Europe (TTF) or Asia (JKM)
- Buyer can hedge exposure: rolling intrinsic or delta hedging

Example of initial intrinsic hedge:

- Winter: buy HH, sell JKM
- Summer: buy HH, sell TTF

Active rehedging based on dynamics of HH/TTF/JKM spread



Issue: liquidity on (JKM) curve

- Proxy hedging in liquid TTF to hedge exposure
- Active management of JKM/TTF correlation

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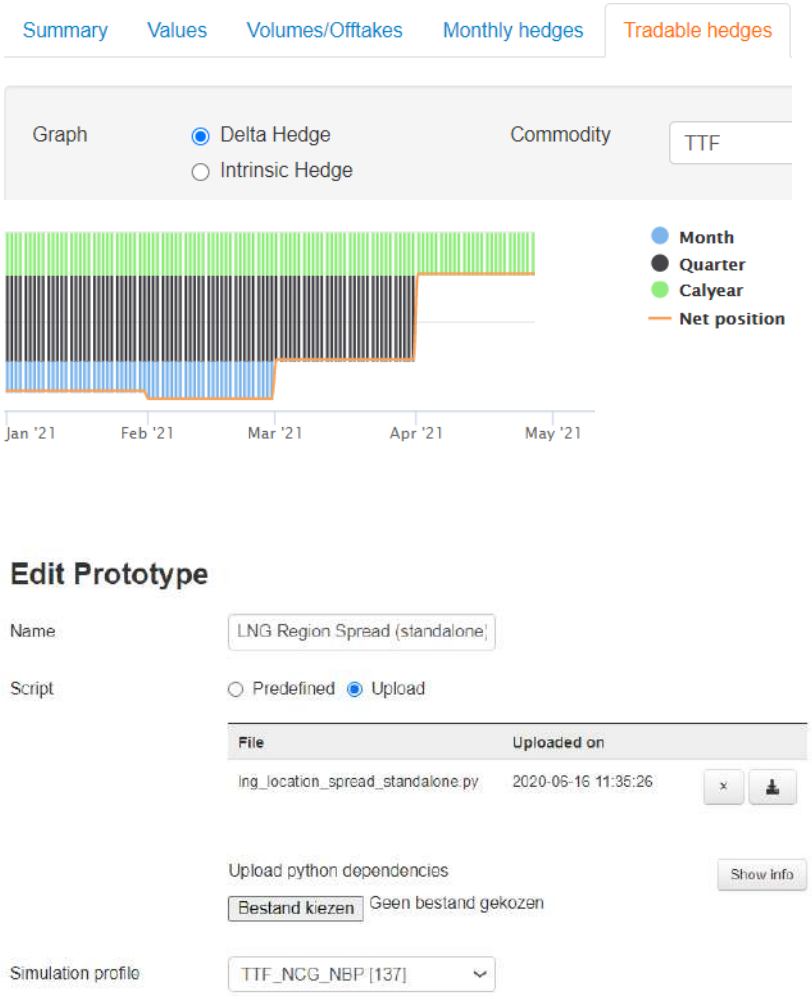
KYOS Analytical Platform

- #1 for valuation & hedging of structured products in (L)NG
- Key LNG modules:
  - Forward curve builder
  - Monte Carlo price simulation engine
  - LNG location and cancelation options
  - LNG portfolio shipping optimization
  - Gas storage
  - Swing contracts
  - Spread options, strips, etc
  - EaR, VaR, risk reporting
- Flexibility:
  - Custom Analytics function to develop additional own models in Python



Questions?

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