PROCESS FOR THE ADJUSTMENT OF THE HHV IN THE LNG PLANTS

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MARKET ASPECTS

- **INCREASING DEMAND FROM THE UK AND THE USA**
- **THE SPECIFICATIONS OF THESE TWO COUNTRIES ARE SIGNIFICANTLY DIFFERENT THOSE OF THE CURRENT MARKET IN TERM OF HHV :**
  - **ASIAN COUNTRIES HAVE HHV OVER 1090 BTU/SCF**
  - **CONTINENTAL EUROPE IN THE RANGE 990 – 1160 BTU/SCF**
  - **UK AND USA ARE BELOW 1065 BTU/SCF**

MARKET ASPECTS

- MOST OF THE LNG PLANTS ARE DESIGN TO SUPPLY THE ASIAN AND CONTINENTAL EUROPE MARKETS
  - NEW PROJECTS HAVE TO ADOPT NEW DESIGNS
  - EXISTING LNG PLANTS MAY HAVE TO BE REVAMPED
- THE LNG HHV HAS TO BE REDUCED EITHER IN LIQUEFACTION PLANTS OR IN LNG TERMINALS

WAY TO GET LEANER LNG IN LNG PLANTS

- **NO ETHANE EXTRACTION AND DEEPER EXTRACTION OF LPG's : REQUIRES ADDITIONAL EQUIPMENT TO THE SCRUBB COLUMN**
- **ETHANE AND LPG's EXTRACTION BY THE SCRUBB COLUMN : DIFFICULT COMMERCIALISATION OF THE ETHANE**

WHICH USE FOR ETHANE ?

WAY TO GET LEANER LNG IN IMPORT TERMINALS

- NITROGEN INJECTION : MAY BE UNSUFFICIENT AS LIMITED BY THE SPECIFICATIONS
- LPG's EXTRACTION : SATISFYING IF SUFFICIENT TO GET THE SPECIFICATIONS
- ETHANE EXTRACTION MAY BE NECESSARY : SAME DIFICULTY OF COMMERCIALISATION AS FOR THE LIQUEFACTION PLANTS, LIMITED POSSIBLE USE IN GT

PROPOSED PROCESS BASIS

- ETHANE EXTRACTION AND SELECTIVE CHEMICAL CONVERSION OF IT INTO METHANE
- EXISTING PROCESS BASED ON THE USE OF JOHNSON MATTHEY CATALYST.
- ETHANE EXTRACTION BY THE SCRUBB AND ITS CONVERSION (INSTEAD OF RE-INJECTION) IS MOST OF THE TIME SUFFICIENT IF THE LPG's ARE NOT RE-INJECTED

CHEMICAL REACTION

- **FIRST STEP : REFORMING**
  - **$4\ C_2H_6 + 9\ H_2O \dashrightarrow 21\ H_2 + 7\ CO + CO_2$**
- **SECOND STEP : METHANATION**
  - **$21\ H_2 + 7\ CO \rightarrow 7\ CH_4 + 7\ H_2O$**
- **OVERALL**
  - **$4\ C_2H_6 + 9\ H_2O \dashrightarrow 7\ CH_4 + 7\ H_2O + CO_2$**

CHEMICAL REACTION FOR BUTANE

- **FIRST STEP : REFORMING**
  - **4 C4H10 + 19 H2O -----> 39 H2 + 13 CO + 3 CO2**
- **SECOND STEP : METHANATION**
  - **39 H2 + 13 CO -----> 13 CH4 + 13 H2O**
- **OVERALL**
  - **4 C4H10 + 19 H2O -----> 13 CH4 + 13 H2O + 3 CO2**

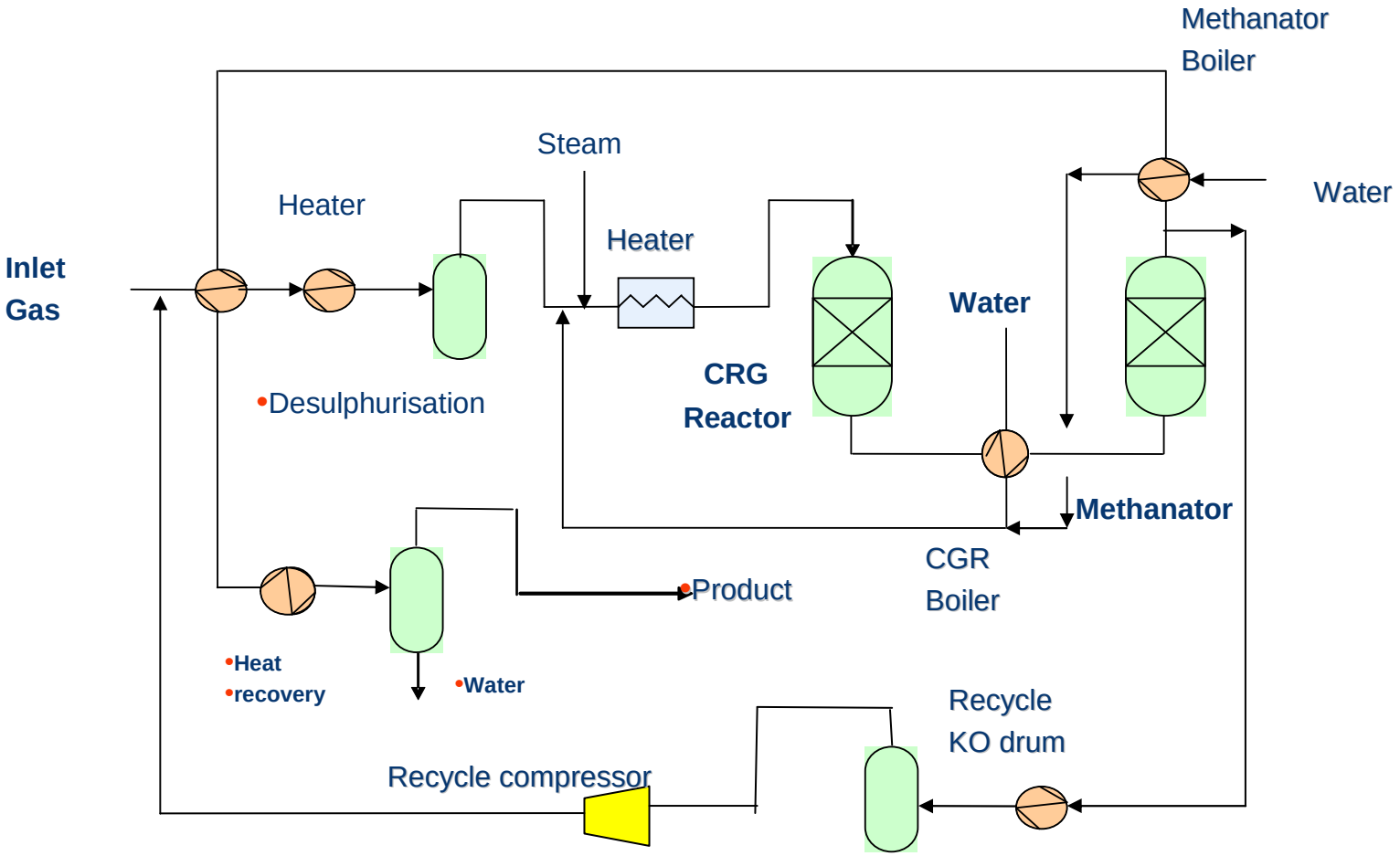
COMPARISON BETWEEN ETHANE AND BUTANE

- **ETHANE :**
  - **4 C_2H_6 + 9 H_2O -----> 7 CH_4 + 7 H_2O + CO_2**

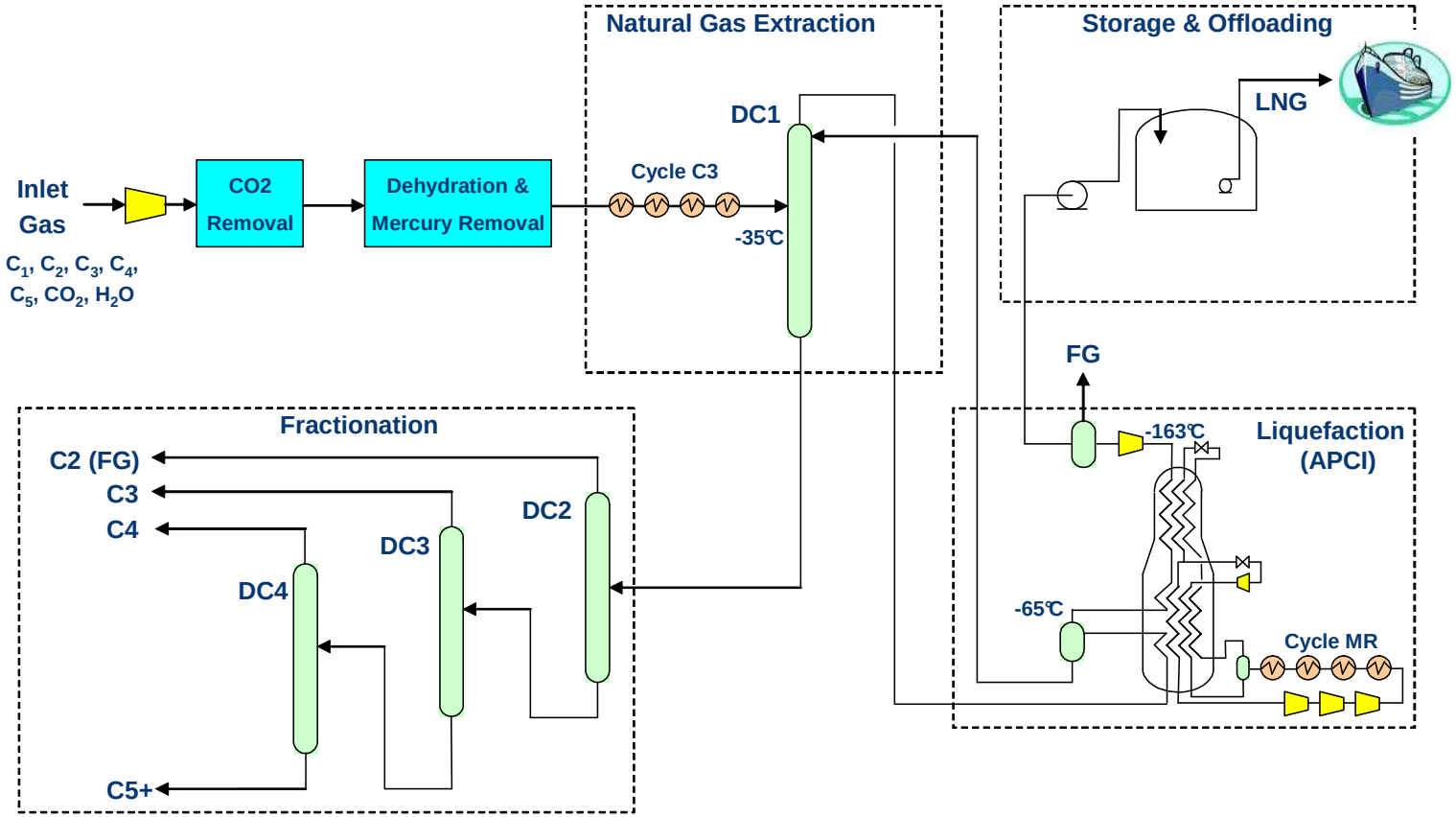
    EFFICIENCY = 87.5 %
- **BUTANE :**
  - **4 C_4H_{10} + 19 H_2O -----> 13 CH_4 + 13 H_2O + 3 CO_2**

    EFFICIENCY = 81.2 %
- **THE CARBON EFFICIENCY IS HIGHER FOR ETHANE THAN FOR BUTANE**

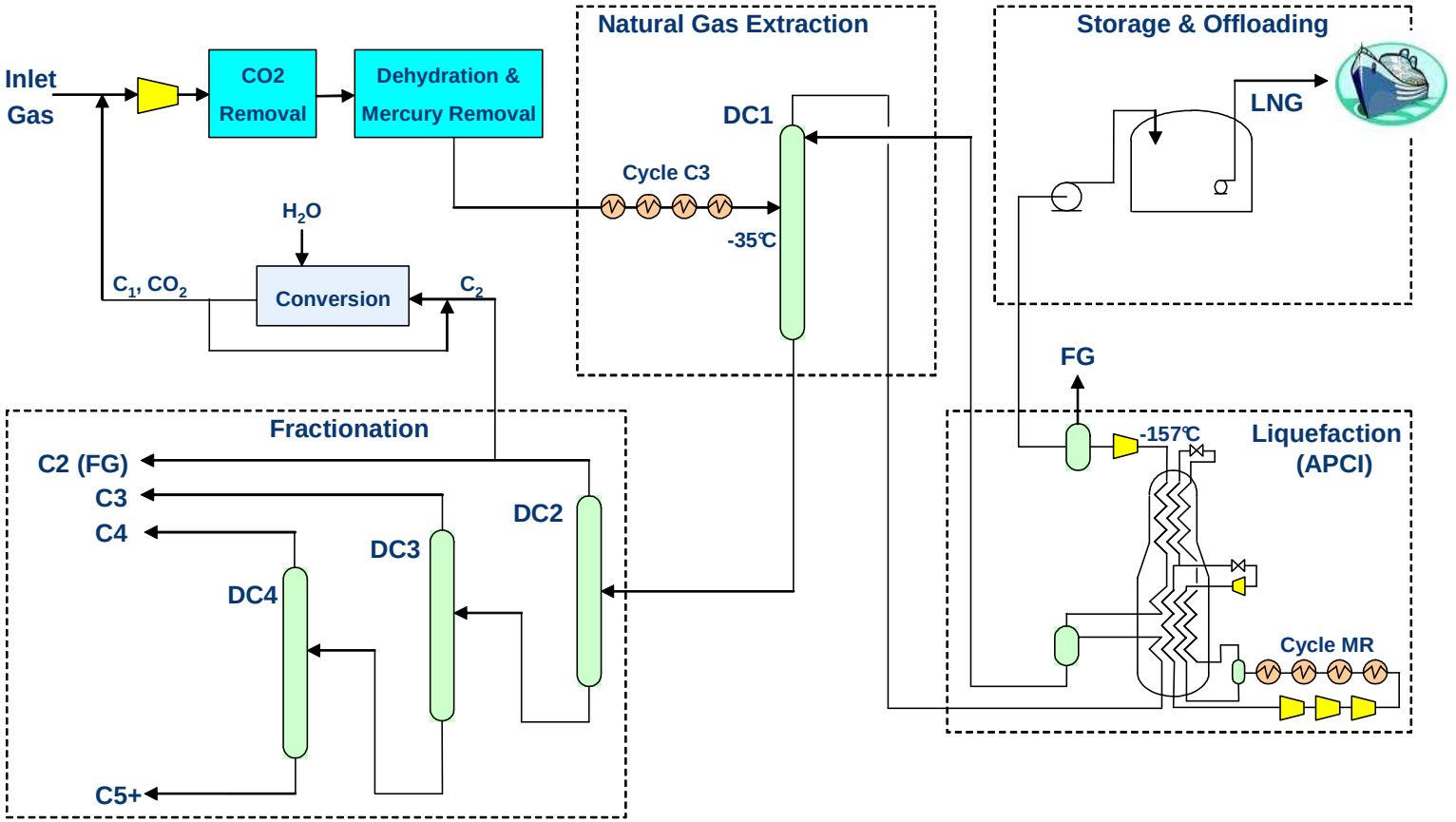
TYPICAL HC CONVERSION PFD



LIQUEFACTION PLANT



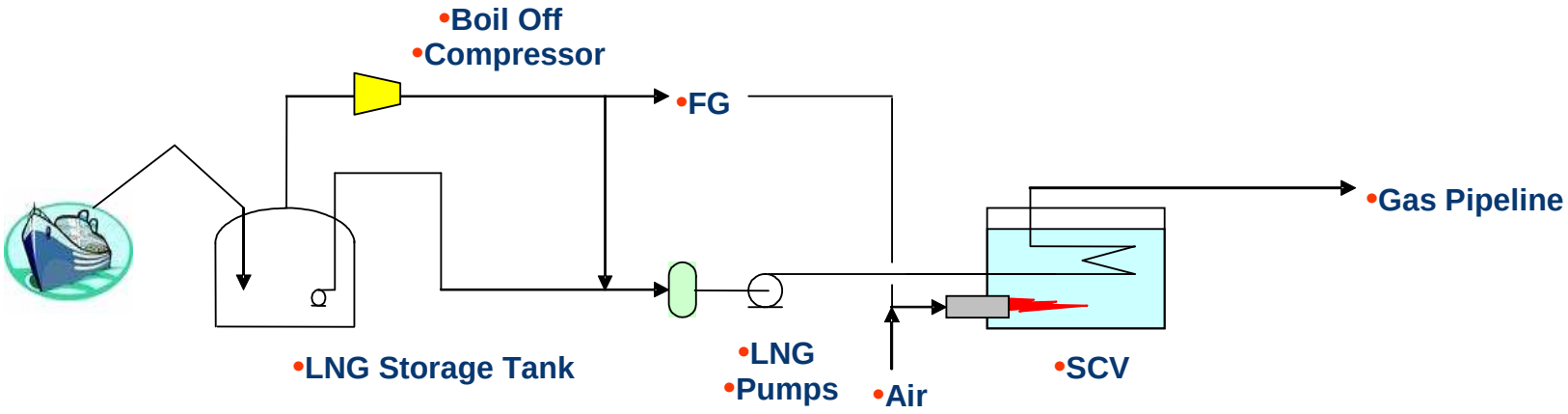
INTEGRATION OF THE CONVERSION IN A LIQUEFACTION PLANT



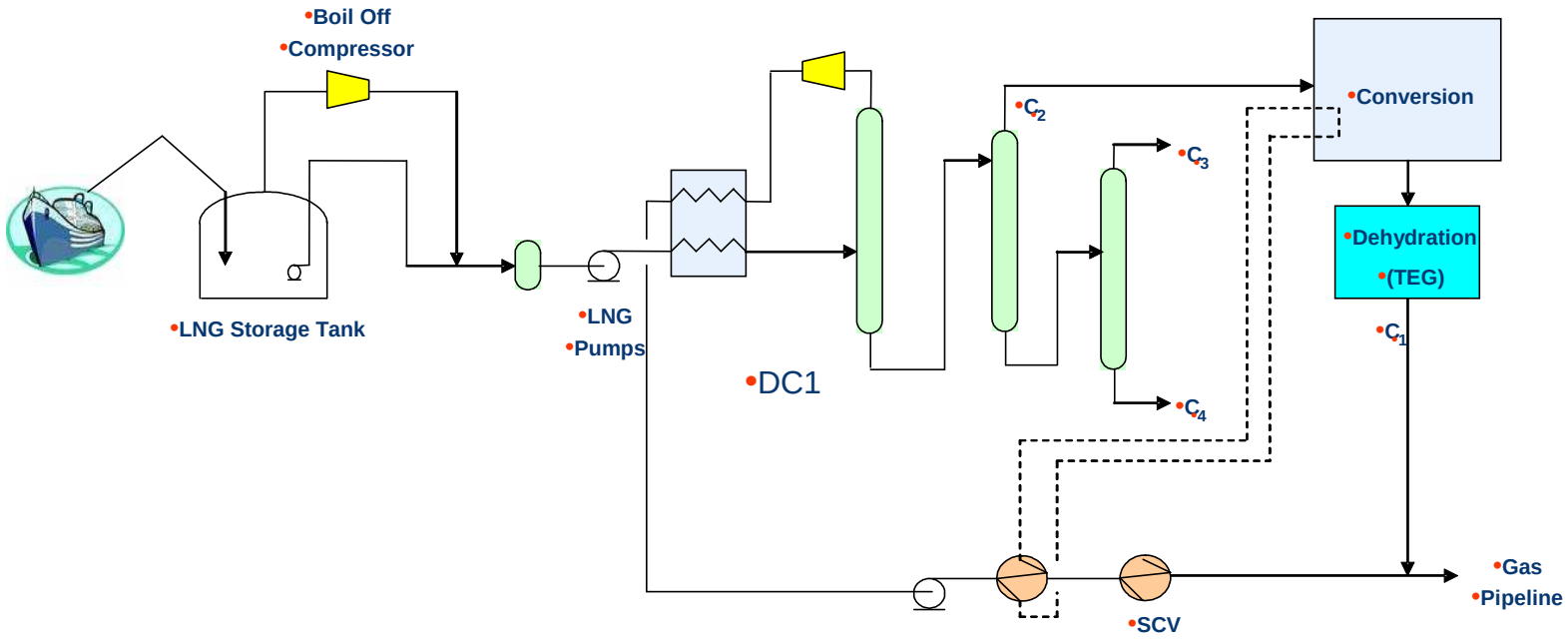
ECONOMICS

- **ORDER OF MAGNITUDE OF THE UNIT COST FOR A 4 MMT/Y LNG PLANT : 15 TO 25 MM$ EX-WORKS**
- **CHEAPER THAN A DEEP LPG EXTRACTION UNIT WITH TURBO-EXPANDER**
- **PROVIDES A SOLUTION FOR THE PRODUCED ETHANE**

LNG TERMINAL



INTEGRATION OF THE CONVERSION IN A LNG TERMINAL



COMPARISON WITH OTHER PROCESS IN LNG TERMINAL

- OPEX AND INCOME OF SALES COMPARISON
- NO INVESTMENT COST

- COMPARISON MADE FOR BOTH UK AND US TERMINAL FOR LNG FROM NIGERIA, AUSTRALIA (NWS) AND QATAR (QATAR GAS II)

COMPARISON WITH OTHER PROCESS IN LNG TERMINAL

- **OPTION 1 : ETHANE CONVERSION & N2 INJECTION (LPG's REINJECTED)**
- **OPTION 2 : ETHANE CONVERSION & LPG EXTRACTION AND SALES**
- **OPTION 3 : NITROGEN INJECTION**
- **OPTION 4 : LPG's EXTRACTION & SALES AND N2 INJECTION**

- **OPTIONS 2 & 4 GIVE SIMILAR RESULTS**
- **OPTIONS 1 & 3 GENERATE LOWER INCOMES**
- **OPTION 1 IS NOT ALWAYS ABLE TO REACH THE HHV VALUE**

CONCLUSION

- **ETHANE CONVERSION IS RELATIVE CHEAP WAY TO REDUCE THE LNG HHV IN THE LIQUEFACTION PLANTS**
- **IT IS COMPETIVE WITH OTHER PROCESSES IN THE LNG TERMINALS**

- **THE OPTIMISED LOCATION IN THE LNG CHAIN IS AT THE TOP OF THE DEETHANISER OF THE LIQUEFACTION PLANT**