QUEST CCS PROJECT

PCCC2 CONFERENCE

BERGEN, NORWAY

SEPT 19, 2013

STEVE PEPLINSKI – QUEST ENGINEERING MANAGER

LOCATION


CANADA
ALBERTA
FORT MCMURRAY
FORT SASKATCHEWAN
EDMONTON
CALGARY
QUEST

INTRODUCTION - THE ATHABASCA OIL SANDS PROJECT

MUSKEG RIVER MINE

ORE

CORRIDOR PIPELINE

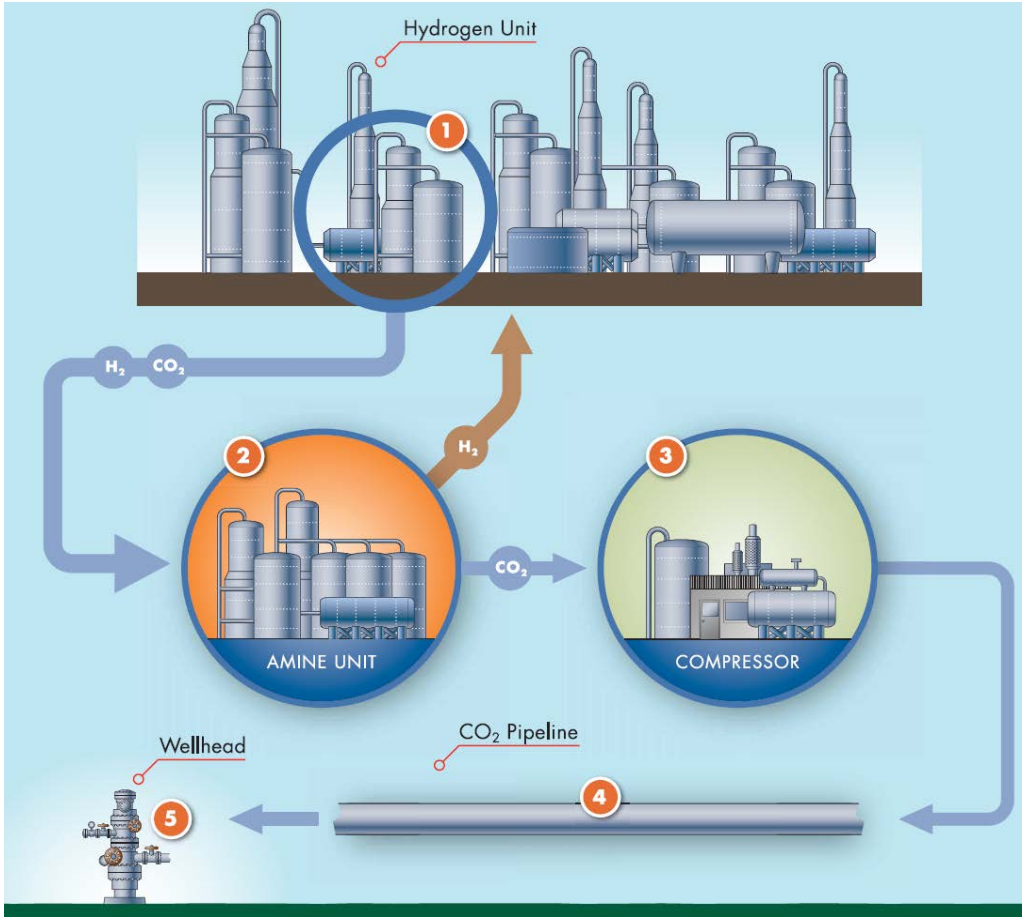
SCOTFORD UPGRADER

BITUMEN TO SYNTHETIC CRU
(255,000 BPD)

SCOTFORD REFINERY (SHELL ONLY)

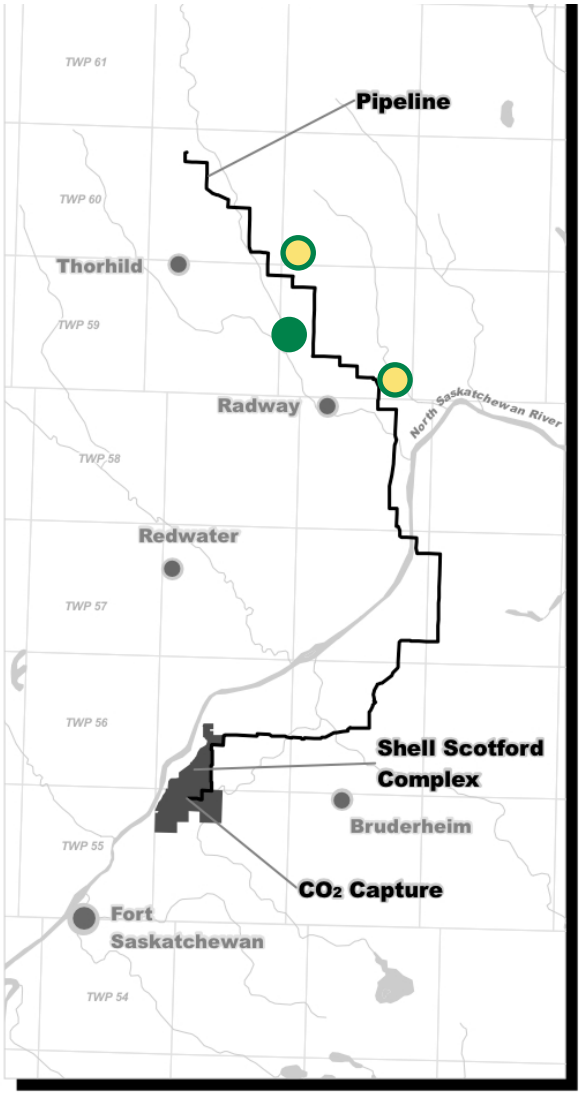
GENERAL FEATURES

- QUEST CCS PROJECT - FULLY INTEGRATED CCS (CAPTURE, TRANSPORT & STORAGE)
- JV AMONG SHELL (60%); CHEVRON (20%); AND MARATHON (20%) – PART OF AOSP
- LOCATED AT SCOTFORD UPGRADER COMPLEX
- ONE MILLION TONNES CO_2 PER YEAR CAPACITY FOR 25 YEARS
- 35% REDUCTION OF UPGRADER CO_2 EMISSIONS
- PROJECT APPROVAL – SEPT 2012



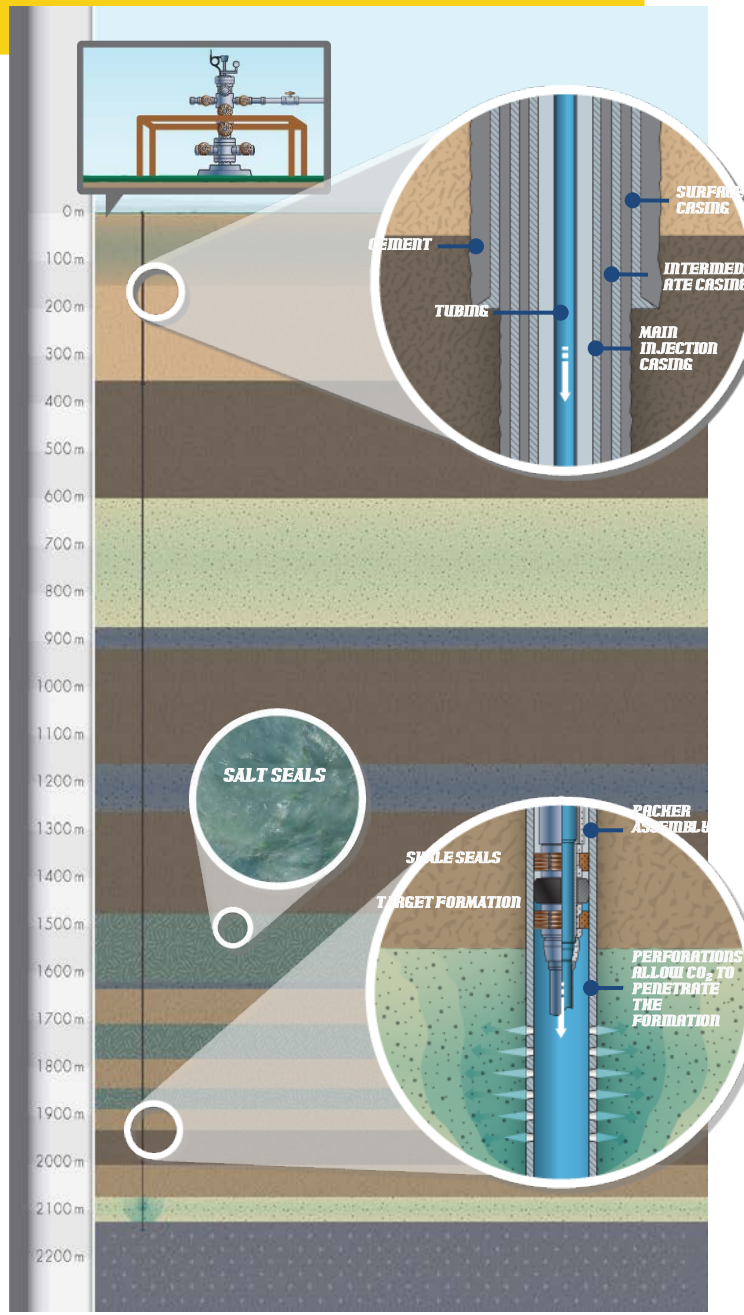
HARDWARE

- CAPTURE AT THE SCOTFORD UPGRADER FROM 3 HYDROGEN MANUFACTURING UNITS
- CO_2 TRANSPORTED BY 12 INCH PIPELINE TO STORAGE, WITH 6 INCH LATERALS
- PIPELINE TO 65 KM NORTH OF THE UPGRADER
- ROUTE SELECTED TO MEET STAKEHOLDER REQUIREMENTS:
  - 28 KM FOLLOWS EXISTING ROW
  - DRILLED UNDER NORTH SASKATCHEWAN RIVER
  - 30+ RE-ROUTES TO ACCOMMODATE LANDOWNER WISHES
- BASE PLAN: 3 INJECTION WELLS AND ASSOCIATED MONITORING

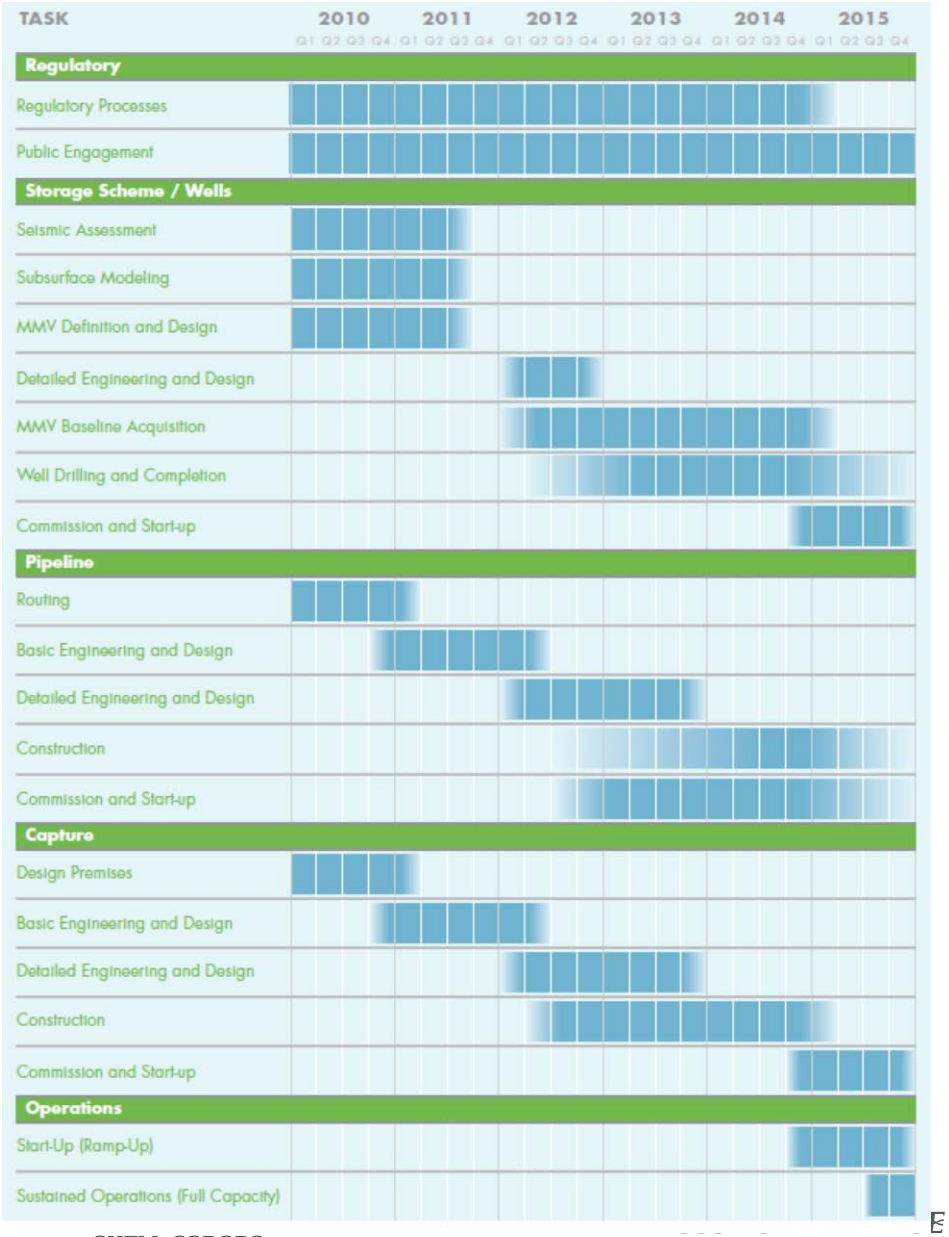


STORAGE

- SALINE AQUIFER STORAGE
- INJECTION FORMATION - BASAL CAMBRIAN SANDS (BCS)
  - 2,300 M DEPTH, PRAIRIES DEEPEST SANDSTONE
  - MULTIPLE CAPROCK AND SALT SEAL LAYERS IN THE STORAGE COMPLEX
  - NO SIGNIFICANT FAULTING VISIBLE FROM WELLS OR SEISMIC
  - THE BCS IS WELL BELOW HYDROCARBON BEARING FORMATIONS AND POTABLE WATER ZONES IN THE REGION
  - RELATIVELY FEW WELLS DRILLED INTO THE BCS, NONE WITHIN 10 KM OF THE PROPOSED STORAGE SITE
- WELLS AND DRILLING
  - CONVENTIONAL DRILLING METHODS



TIMELINE AND UPCOMING ACTIVITIES



- WELL PROGRAM
  - DRILLING FINISHED, COMPLETIONS ONGOING
- CAPTURE & PIPELINE
  - ENGINEERING FINALIZED
  - SITE UNDERGROUND CONSTRUCTION COMPLETE
  - FIRST MODULE DELIVERY Q4 2013
  - MAJOR EQUIPMENT DELIVERIES COMPLETE
  - PIPELINE CONSTRUCTION BEGINS Q3 2013
- COMMUNITY ADVISORY PANEL
  - INITIAL KICKOFF IN JANUARY, WITH REGULAR UPDATES
- FINAL REGULATORY APPROVALS
  - PIPELINE LATERALS EXPECTED END 2013

PROCESS SELECTION & INTEGRATION

1. WHY ACTIVATED AMINE (ADIP-X)?
2. HMU INTEGRATION ISSUES
3. CO2 COMPRESSION, INTEGRATION WITH PIPELINE AND WELLS

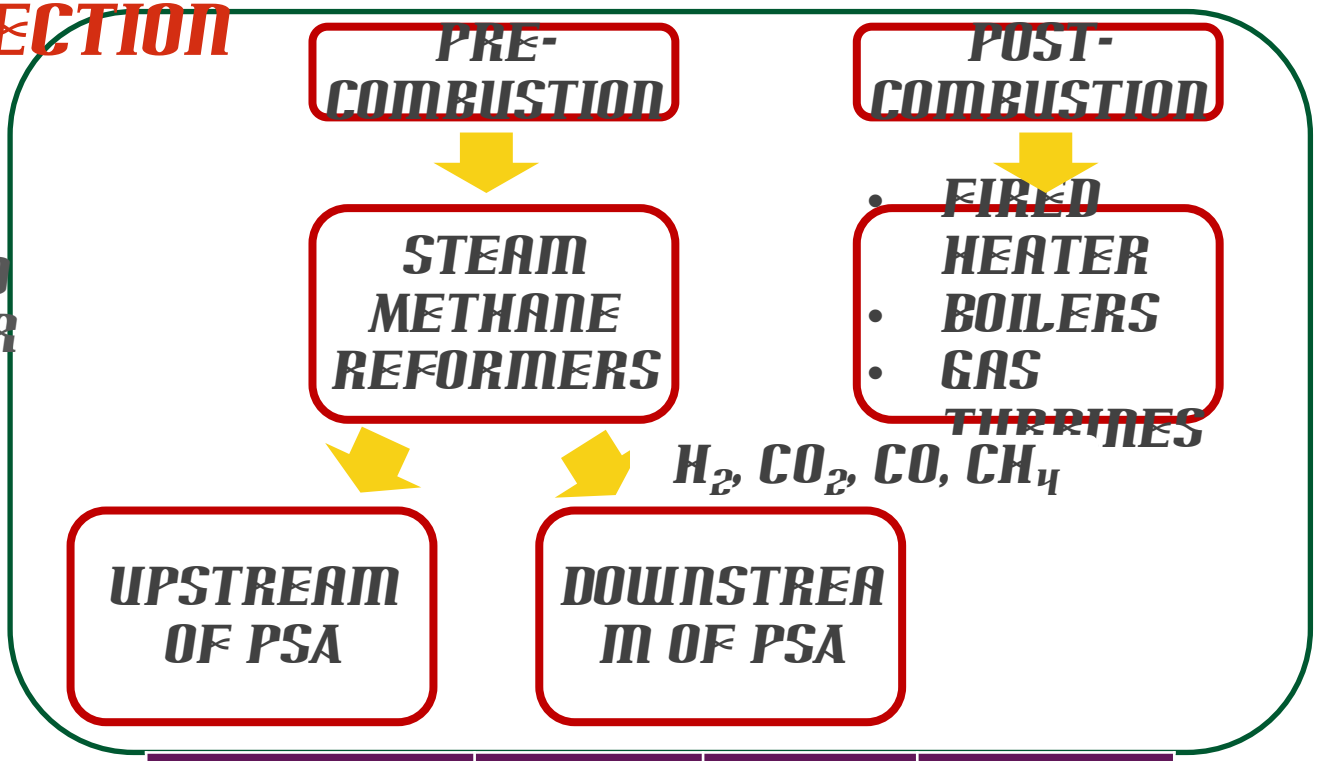
WHY ACTIVATED AMINE (ADIP-X)?

PROCESS SELECTION COMPLETED IN Q1 2010 WITH THE FOLLOWING CONSTRAINTS:

- DESIGN BASIS CAPACITY OF 1.2 MILLION TONNES PER YEAR, ON-STREAM FACTOR OF 90% = 1.08 MILLION TONNES PER YEAR CALENDAR DAY CAPACITY
- MAXIMUM PRESSURE DROP THROUGH THE CO_2 FACILITY LESS THAN 70 KPA
- TEMPERATURE OF THE PSA INLET GAS AFTER CO2 CAPTURE SHALL NOT EXCEED 35°C IN ORDER TO MAINTAIN THE H2 ABSORPTION CAPACITY
- CHEMICAL SOLVENT CARRYOVER TO THE PSA SHOULD BE LESS THAN 1 PPMW. CHEMICAL SOLVENTS CAN CONTAMINATE THE PSA'S ADSORBENTS.
- ONSITE ELECTRICAL POWER AVAILABILITY LIMITED DUE TO HV SUBSTATION CONSTRAINTS

WHY ACTIVATED AMINE (ADIP-X)? - CO_2 SOURCE SELECTION

SCOTFORD UPGRADER



SELECTION DRIVER

PARAMETER	POST-COMB	D/S OF PSA	U/S OF PSA
SYSTEM PRESSURE	X	X	√
CO_2 CONCENTRATION	X	√	√
CO_2 PARTIAL PRESSURE	X	X	√
OTHER IMPURITIES	X	√	√
PLOT SPACE	X	X	√

WHY ACTIVATED AMINE (ADIP-X)?

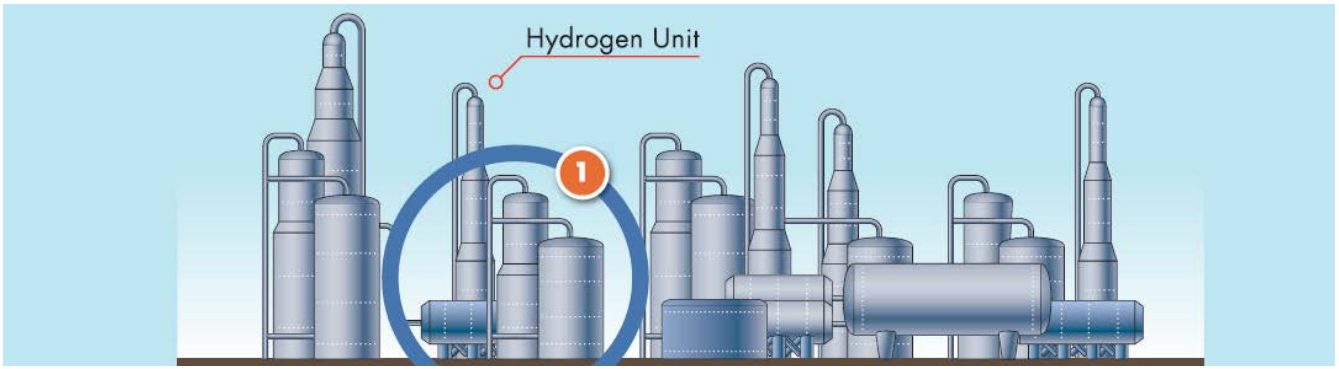
CRITERIA	ADIP-X	MDEA	SELEXOL	MEMBRANE	PSA	METHANOL ABSORPTION	AMMONIA ABSORPTION	LIQUE-FACTION
HSE RISKS								
CAPEX								
OPEX								
HMU RELIABILITY EFFECTS								
COMMERCIAL								
CONSTRUCTABILITY								

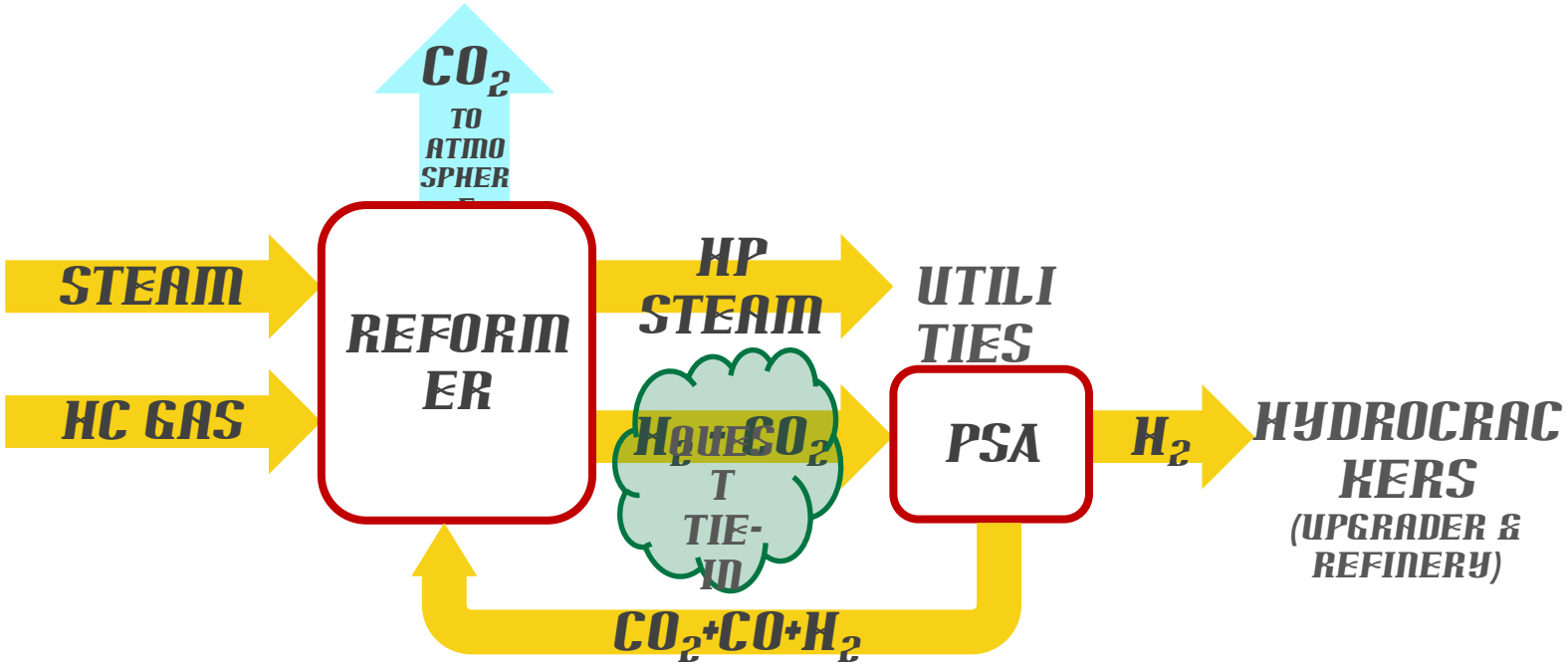
INFLUENCING FACTORS

- CONSTRUCTION IN BROWNFIELD LOCATION INFLUENCED 75% OF OPTIONS
- COMMERCIAL SCALABILITY UNPROVEN FOR 5 OF 8 OPTIONS
- LOCAL OPEX FACTORS - STEAM VERSUS ELECTRICITY COSTS

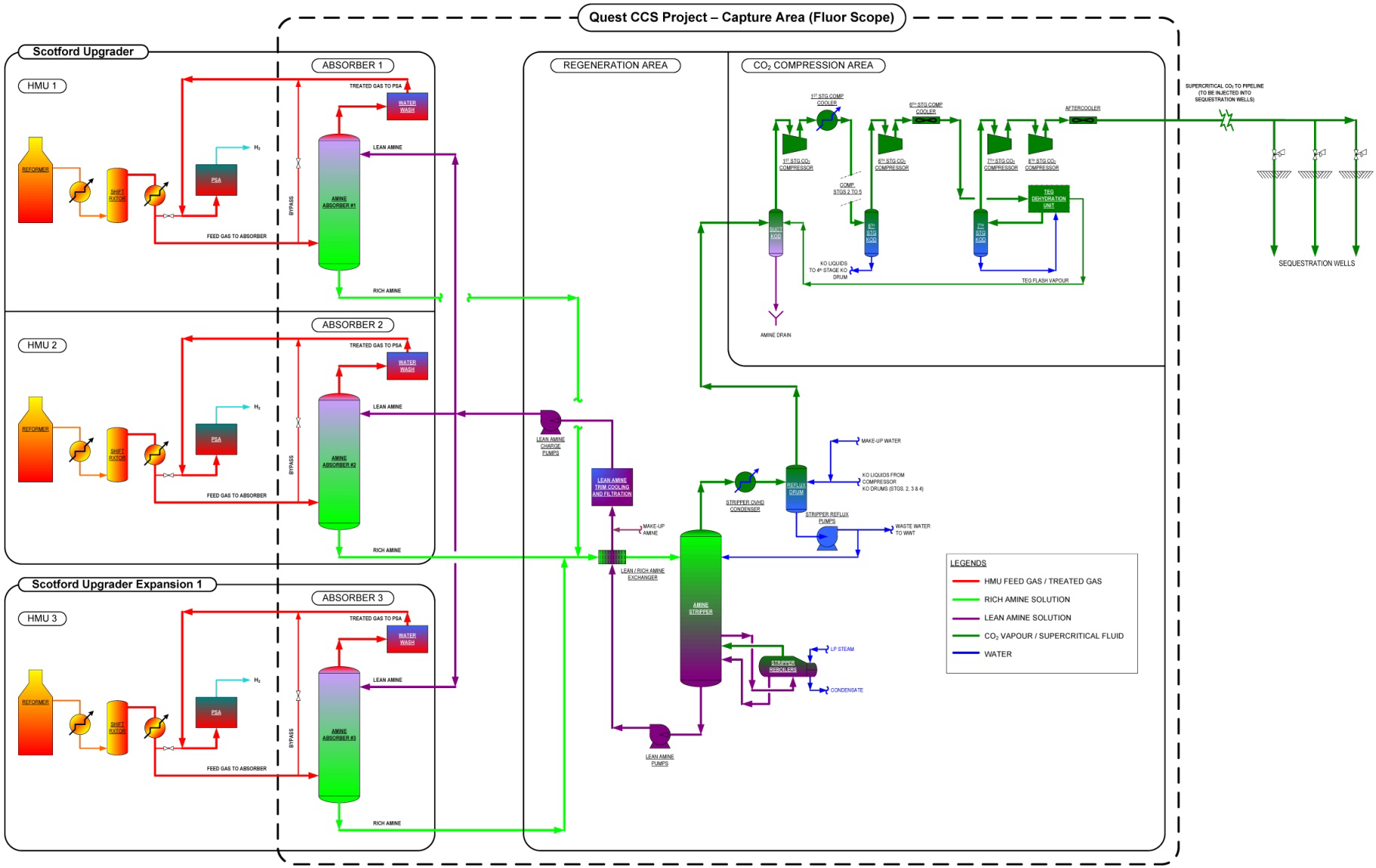
QUEST – CAPTURE FACILITIES

SCOTFORD UPGRADER

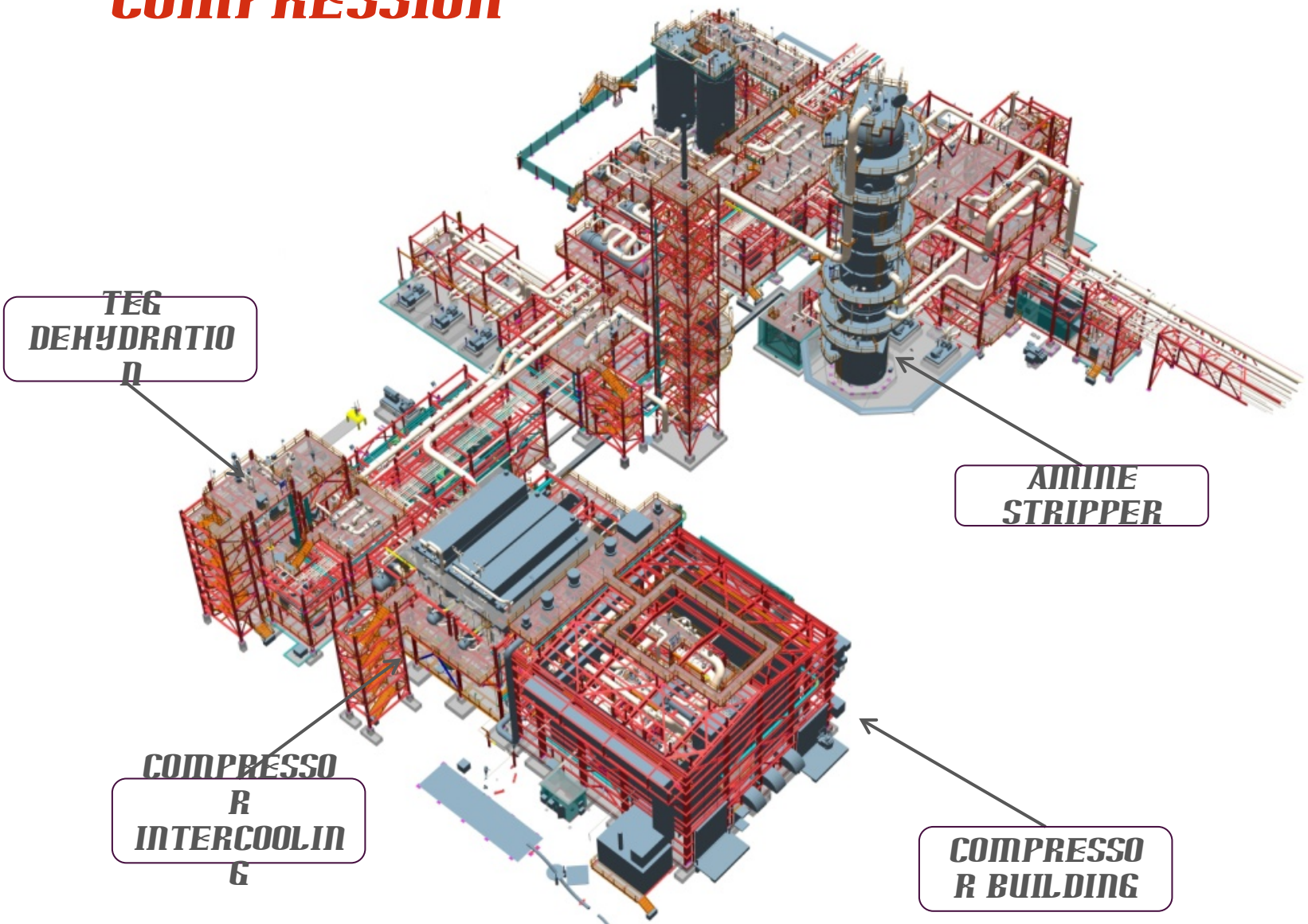




CAPTURE DESIGN



CAPTURE 3D MODEL – AMINE STRIPPER & CO2 COMPRESSION



INTEGRATION WITH EXISTING HMUS

- HMU OPERATION
- STEAM BALANCE

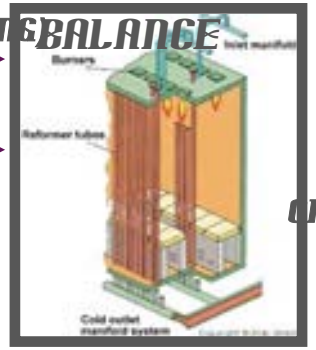
MAKEUP FUEL (NG)

STEAM + NG

LOSS OF CO2

PRODUCT H2

- PSA ADSORBENT FILL
- CONTROL SYSTEM



CH4 + SLIP H2 & CO2 OFF GAS FUEL

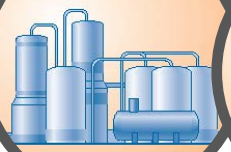
H2 MANUFACTURING UNIT

PRESSURE SWING ADSORPTION (PSA) H2 SEPARATION

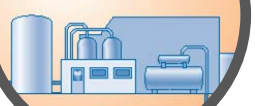
3 STORAGE SITE

STORAGE COMPLEX 2 KM DEEP

1 AMINE UNIT



COMPRESSOR



- DENSE PHASE TRANSPORT
- CAPACITY
- LET DOWN AT CHOKE VALVE

CO_2

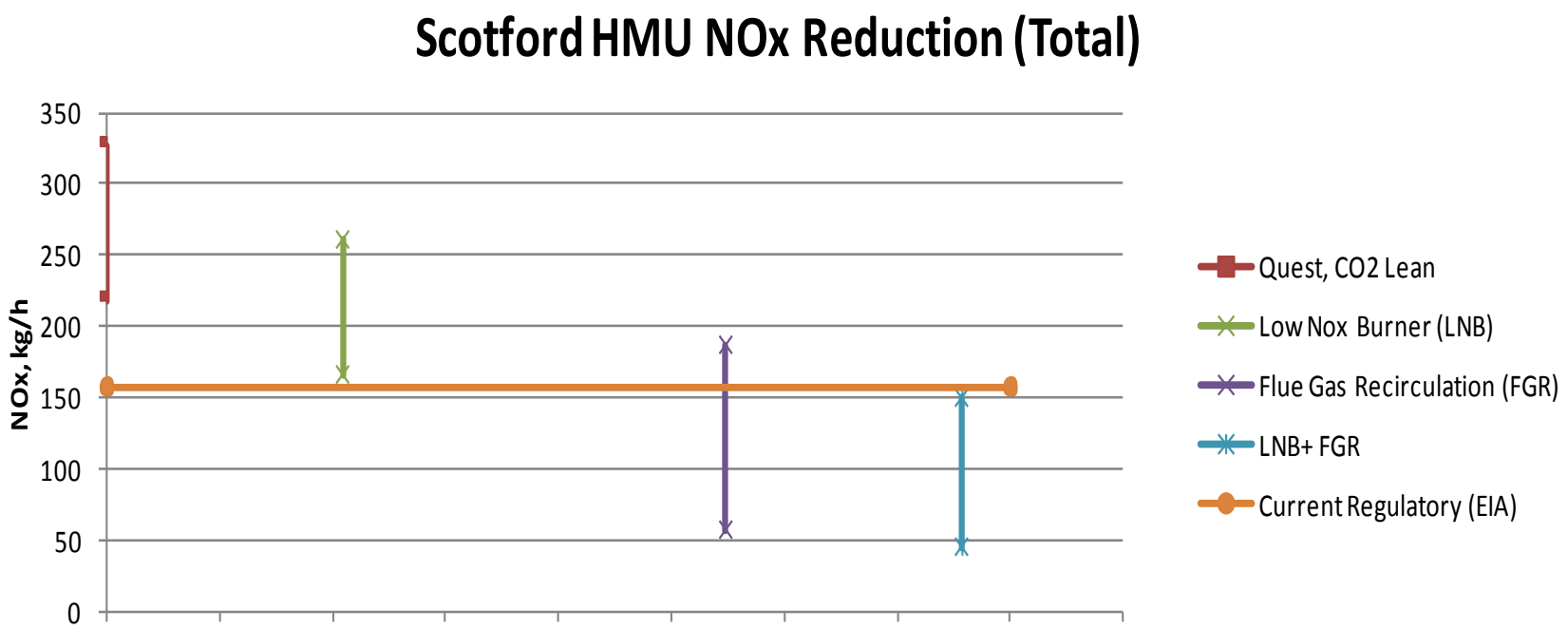
2 CO_2 PIPELINE

INTEGRATION WITH EXISTING HMUS

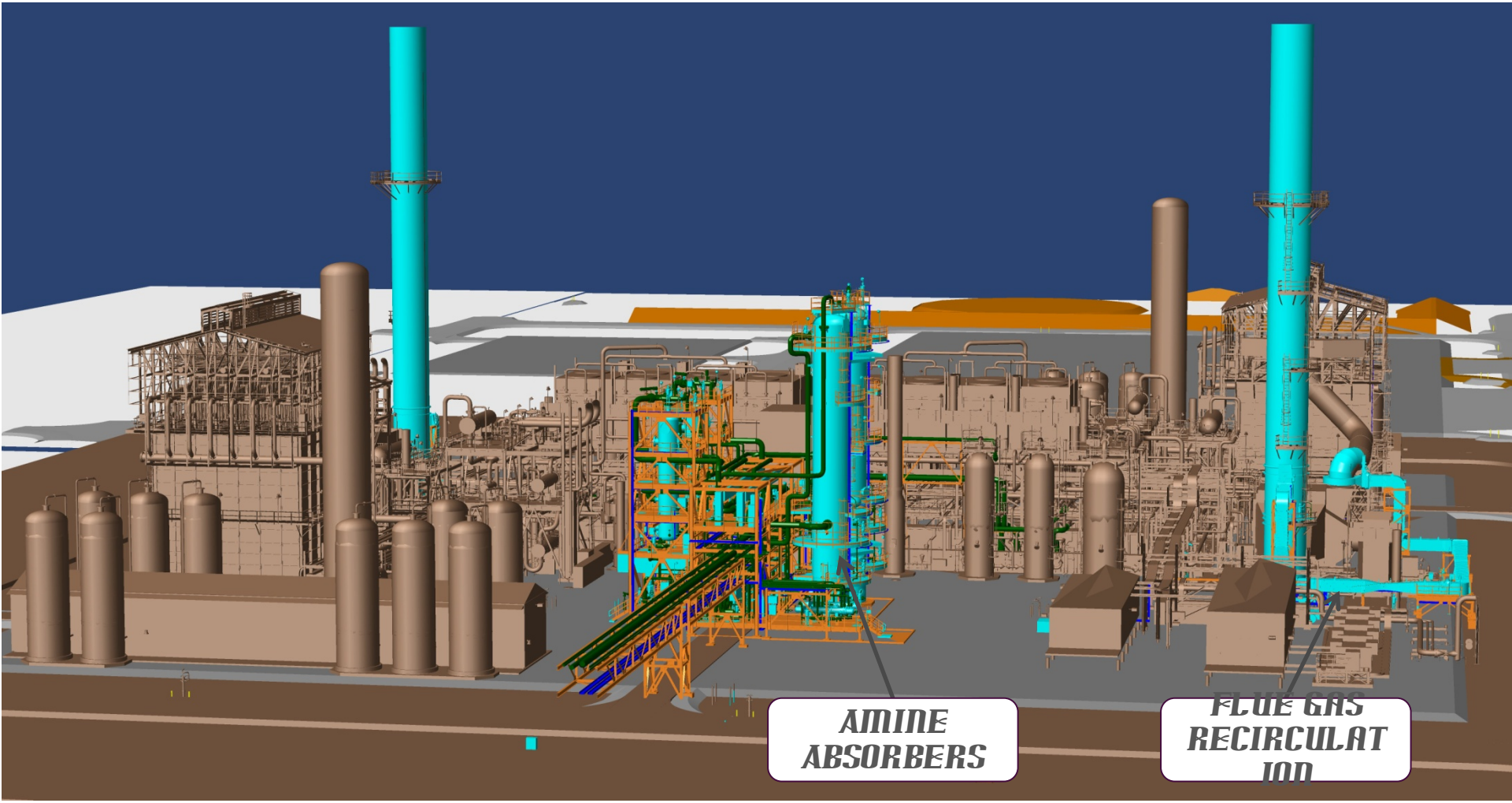
- WHAT DOES HMU DO WHEN QUEST IS ONLINE/OFFLINE?
  - VERIFY REFORMER BOX TRIP OCCURRENCES VIA DYNAMIC ANALYSIS
  - CONFIRM STEAM BALANCE WITHIN HMUS FOR FGR ON/OFF
- LOSS IN H2 PRODUCTION DUE TO QUEST?
  - PSA REVISED ADSORBENT FILL TO POST QUEST OPTIMIZED LOADING
- 70 KPA PRESSURE DROP FORCED PIPING UPSIZING
- ISSUES – REMOVING CO_2 IMPACTS HMU NOX PRODUCTION
  - LOW NOX BURNERS C/W TESTING (BURNER MANAGEMENT SYSTEM RELOOK)
  - FLUE GAS RECIRCULATION – PERMUTATIONS

HMU NOx

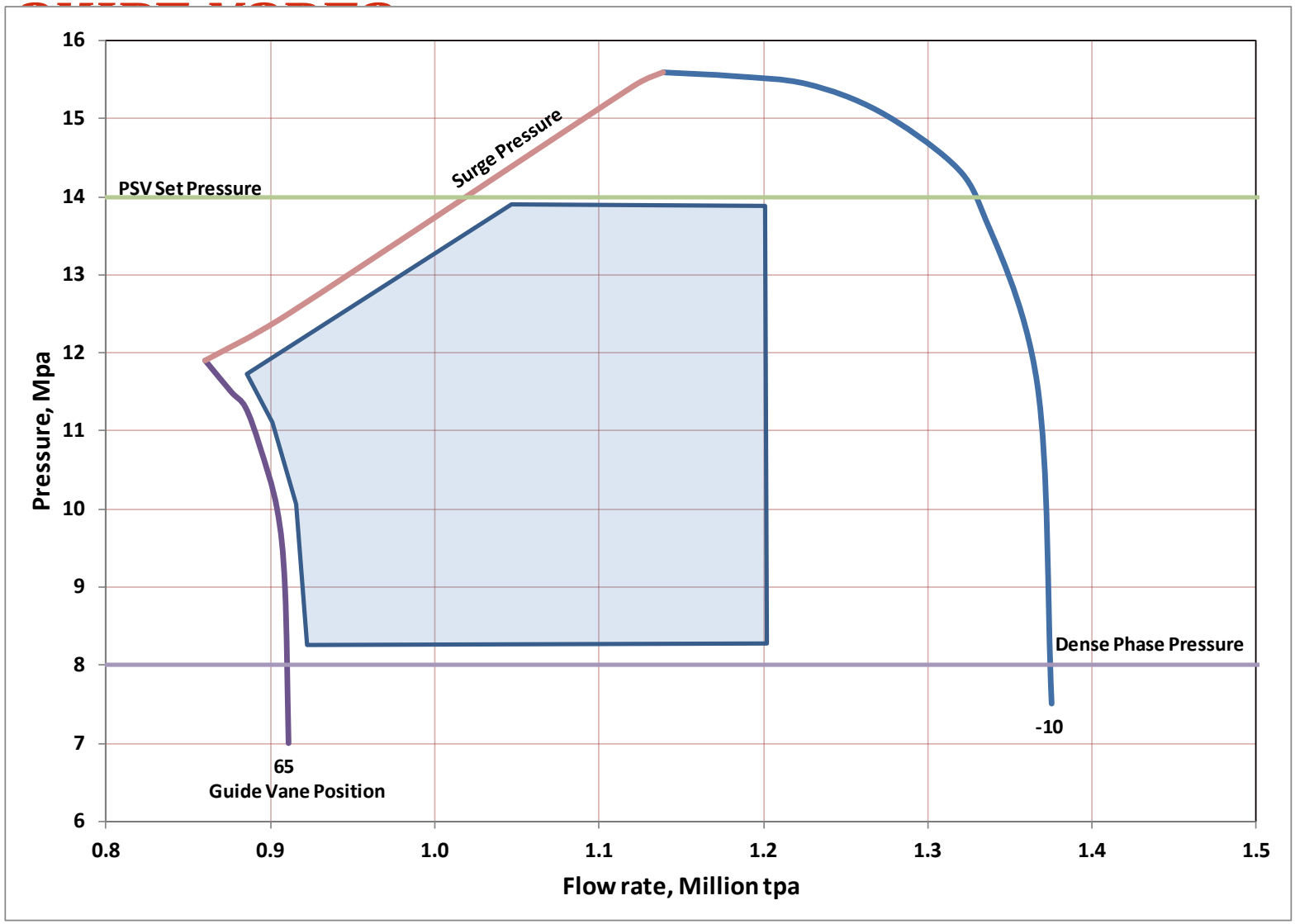
Emission Source	Air Contaminant/ Parameter	Current Limit	Requested Limit
Expansion HMU flue stack (S-44103)	Nitrogen oxides	62.7 kg/h	130.0 kg/h
Base plant Train 1 hydrogen manufacturing unit flue stack (S-24103)	Nitrogen oxides	47.5 kg/h	76.5 kg/h
Base plant Train 2 hydrogen manufacturing unit flue stack (S-24203)	Nitrogen oxides	47.5 kg/h	76.5 kg/h



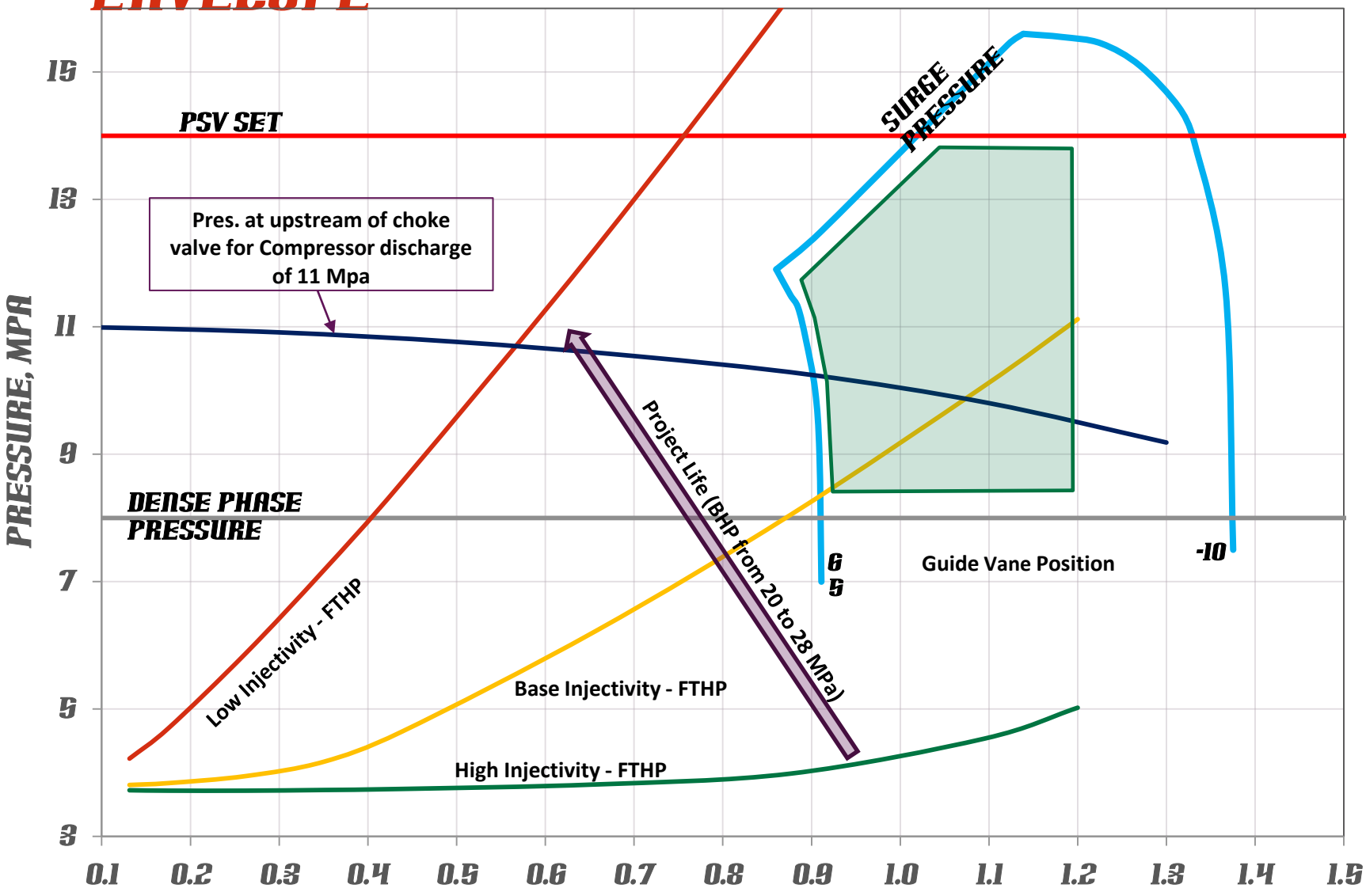
HMU 1 & 2 SCOPE



COMPRESSOR OPERATING ENVELOPE INTEGRALLY GEARED, 8 STAGES WITH INLET GUIDE VANES



INTEGRATION OF CAPTURE/PIPELINE/WELLS - ENVELOPE



LEARNINGS AND CONCLUSION

- QUEST IS THE FIRST COMMERCIAL SCALE CCS PROJECT IN CANADA
  - PACE SETTER FOR OTHER EFFORTS TO MANAGE CO_2 FOOTPRINT IN ALBERTA
  - ABUNDANT LEARNINGS FOR FUTURE PROJECTS
- KEY SUCCESS FACTORS
  - EARLY AND EXTENSIVE STAKEHOLDER ENGAGEMENT
  - USE OF PROVEN TECHNOLOGY
- SYSTEM OPTIMIZATION (FIT FOR PURPOSE) AND INTEGRATION ARE IMPORTANT TO MINIMIZE LIFE CYCLE COST
  - HMU INTEGRATION
  - UTILITIES INTEGRATION
  - CAPTURE OPTIMIZATION
- WORTH CONSIDERING
  - CAPTURE READY HMU'S OR CO2 PRODUCERS
  - IMPROVEMENTS IN COMPRESSOR CONFIGURATION

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EST
THANK YOU!

NEXT STEPS

- INTO 'EXECUTE' PHASE TO STARTUP IN 2015
- 2013 MAJOR ACTIVITIES:
  - COMPLETION OF DETAILED ENGINEERING
  - BEGIN MAJOR CONSTRUCTION END 2012 (MOD YARD WORK)
  - MAJOR EQUIPMENT DELIVERY AND SETTING ONSITE
  - MMV BASELINE DATA GATHERING
  - BEGIN OPERATIONS READINESS AND TRAINING
  - COMPLETION OF REGULATORY APPLICATIONS (PIPELINE LATERALS)
  - ONGOING STAKEHOLDER MANAGEMENT

COSTS/REVENUES AND FUNDING AGREEMENTS

- TOTAL COST OF QUEST – CDN$1.4 BILLION
  - INCLUDES PRE FID, CAPITAL AND 10 YEARS OPEX
  - CAPITAL RATIO: 80% CAPTURE, 10% PIPELINE, 10% WELLS
- REVENUES – GHG OFFSETS (CREDITS)
  - NET AMOUNT – STORED CO2, LESS DIRECT AND INDIRECT EMISSIONS
  - CREDITS TO BE USED FIRST BY SHELL'S ALBERTA ASSETS FOR REGULATORY COMPLIANCE
- GOVERNMENT FUNDING SUPPORT – CDN$865 MILLION
  - CDN$120 MILLION CANADIAN FEDERAL GOVERNMENT (PRE FID)
  - CDN$ 745 MILLION ALBERTA PROVINCE (CONSTRUCTION, STARTUP AND 10 YEARS OPERATION)
  - EXTENSIVE KNOWLEDGE SHARING
  - STRINGENT MONITORING (MMV) PLAN
  - NPV ZERO COMMITMENT

REGULATORY FRAMEWORK

- PROVINCIAL GHG FRAMEWORK ESTABLISHED
  - CCS ACT PASSED IN NOV 2010, ESTABLISHING OVERALL STRUCTURE
  - PORE SPACE REGULATIONS IN PLACE WITH QUEST SUCCESSFULLY ACQUIRING REQUIRED AREA IN MAY 2011
  - PARTICIPATION IN REGULATORY FRAMEWORK ASSURANCE (RFA) PROCESS AND GHG OFFSET PROTOCOL REVISIONS
  - NO FEDERAL FRAMEWORK TO DATE – POSSIBLE 2013

- REGULATORY APPROVALS NEAR COMPLETE
  - FEDERAL COMPLIANCE ACHIEVED – EIA SUBMITTED, COMPLETED INTERNAL AND PUBLIC REVIEW
  - BUNDLED PROVINCIAL APPLICATION SUBMITTED – UPGRADER AMENDMENT, PIPELINE, WELL AND STORAGE
  - 3 ROUNDS OF INFORMATION REQUESTS (200+) BY PROVINCIAL REGULATOR, THE ERCB
  - ERCB PUBLIC HEARING MARCH 2012
  - SUMMER WORKS AND DRILLING PERMITS TO FOLLOW ERCB DECISION

GENERAL PROJECT ASSESSMENT

- GENERAL ASSESSMENT – VERY POSITIVE
  - MAJOR PROJECT ATTRIBUTES (TECHNICAL, COSTS, REGULATORY, STAKEHOLDERS) TRACKING AS PLANNED
- PROJECT SUCCESSES
  - GOVERNMENT FISCAL SUPPORT
  - PORE SPACE TENURE
  - CAPTURE AND PIPELINE FRONT END ENGINEERING AND DESIGN (FEED) COMPLETION AND ASSURANCE
  - TEST WELL AND AQUIFER PROPERTY VERIFICATION
  - STAKEHOLDER ENGAGEMENT
  - PIPELINE ROUTING FINALIZATION
  - DNV CERTIFICATION OF THE STORAGE DEVELOPMENT PLAN
  - REGULATORY HEARING
- CHALLENGES
  - CAPITAL COSTS
  - SCHEDULE PRESSURE
  - REGULATORY UNCERTAINTY (GHG PROTOCOLS, FEDERAL FRAMEWORK)