

تحت رعاية صاحب السمو الشيخ محمد بن زايد آل نهيان، رئيس دولة الإمارات العربية المتحدة

Under the Patronage of H.H Sheikh Mohamed Bin Zayed Al Nahyan, President of the United Arab Emirates



Carbon Capture Solvent Technology Selection Using Process Simulation

ADIPEC 2023 DOWNSTREAM TECHNICAL CONFERENCE

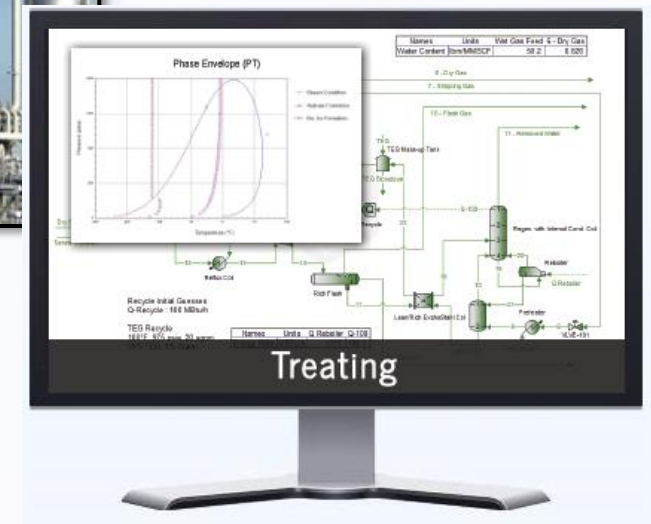
Ganank Srivastava

Bryan Research & Engineering LLC

Agenda

Topics to be Covered

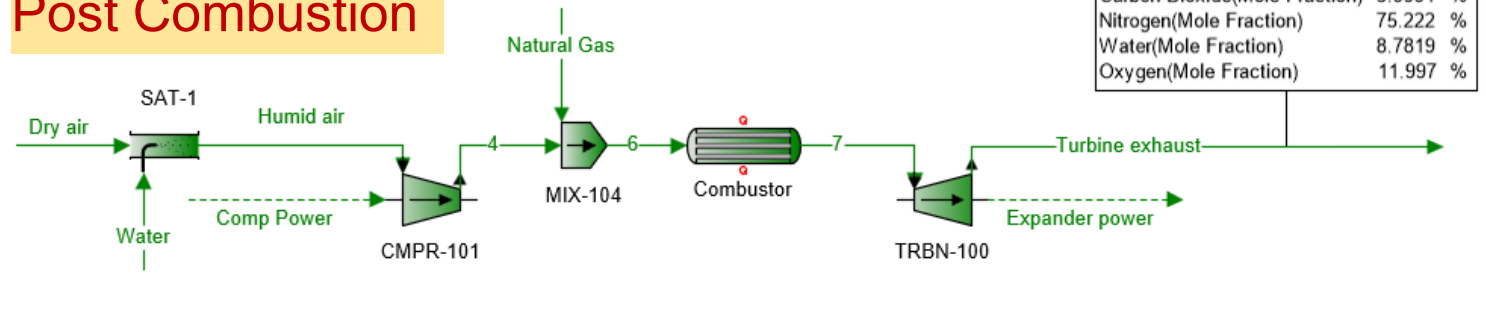
- Introduction - Opportunities for CO2 Capture
- Available Technologies
- Process Model Basis
- Pressure Comparisons
- Energy Duty Comparisons
- Other Key Considerations
 - Feed Temperature Management
 - Contaminants Handling (e.g. SOx)
 - Contactor Internals
 - High CO2 Streams (e.g. Reboiler)
 - Solvent losses
- Final Developed Process Model Scheme
- Conclusion and Technology Map Summary



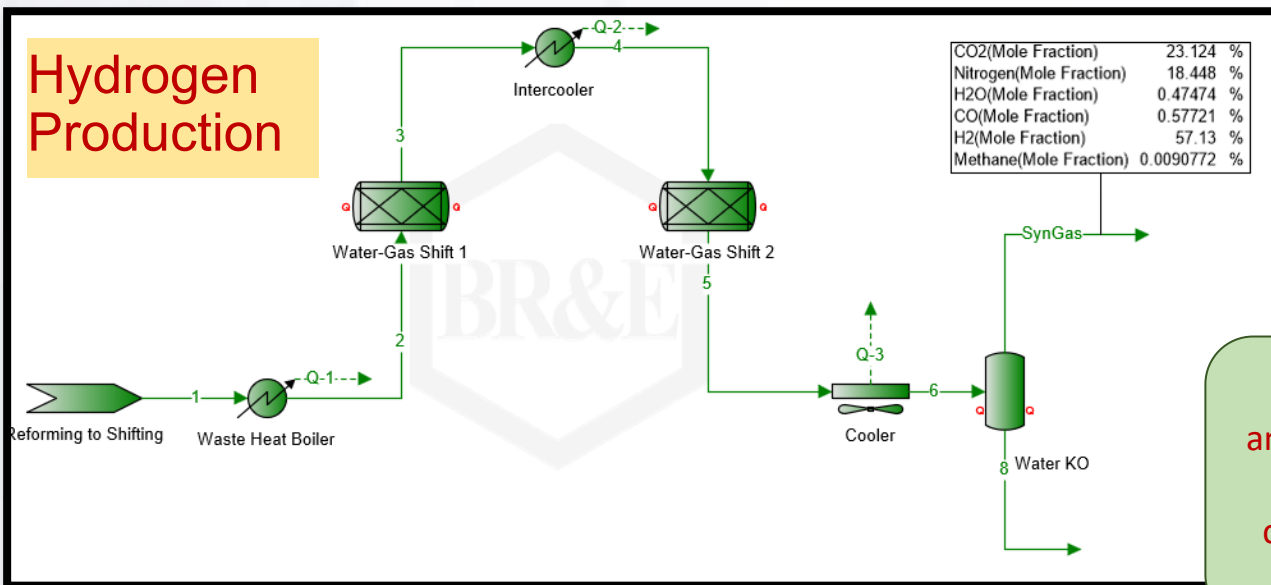
Introduction

Opportunities for CO2 Capture

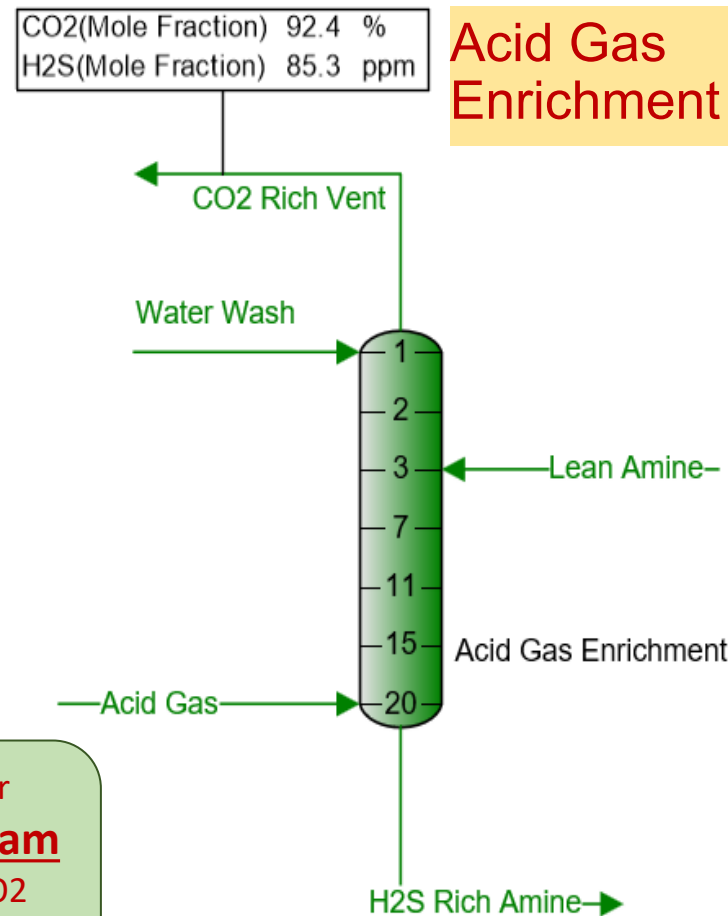
Post Combustion



Hydrogen Production



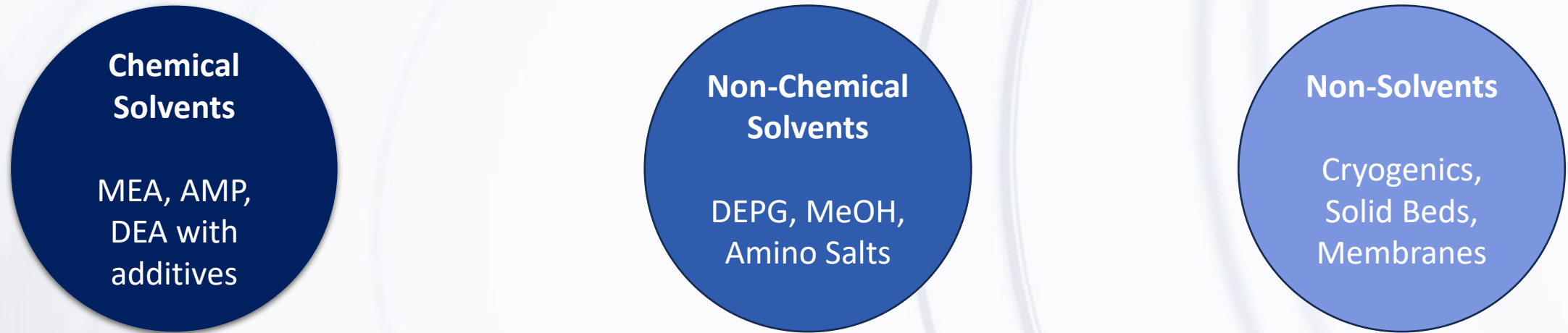
Acid Gas Enrichment



We will be basing our analysis on a **PCC stream** as it has the lowest CO2 concentration amongst all target streams

Introduction

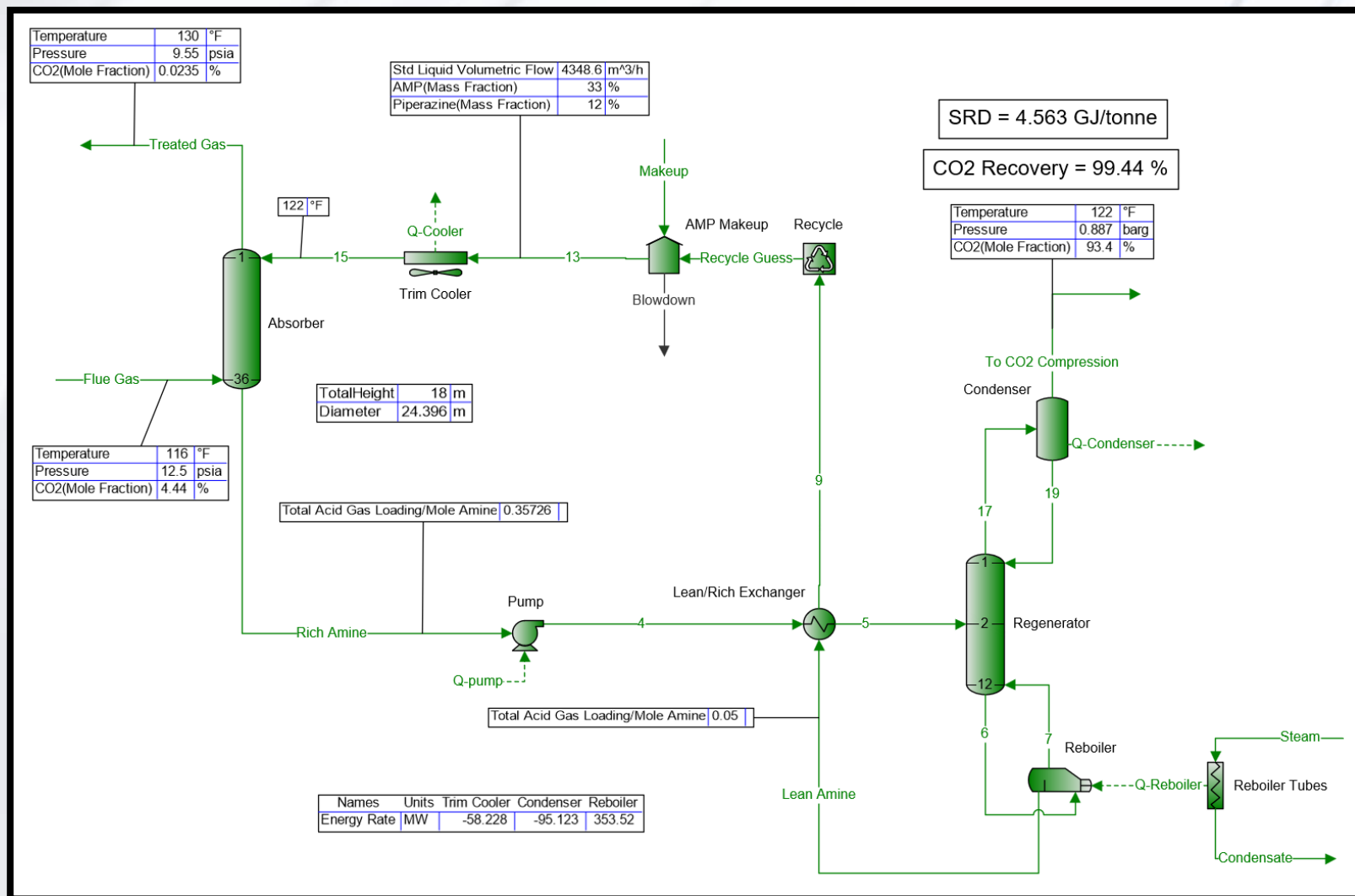
Available Technologies



We will be basing our analysis in comparing **Chemical Solvents vs Physical Solvents**

Process Simulation Model of CC

On ProMax® Software Developed by BR&E



- ProMax® process simulation model is used to develop this CO2 capture unit
- ProMax® is a tool developed by Bryan Research & Engineering (BR&E) and utilized by number of CCUS licensors
- Proprietary kinetic models predicting accurate CO2-amine thermodynamic behavior is running at the background of the simulation tool

Simulation Study

Pressure Comparisons



CO2 RECOVERY AT ATM PRESSURES (PCC STREAM)

CHEMICAL SOLVENT



80x more efficacy

PHYSICAL SOLVENT

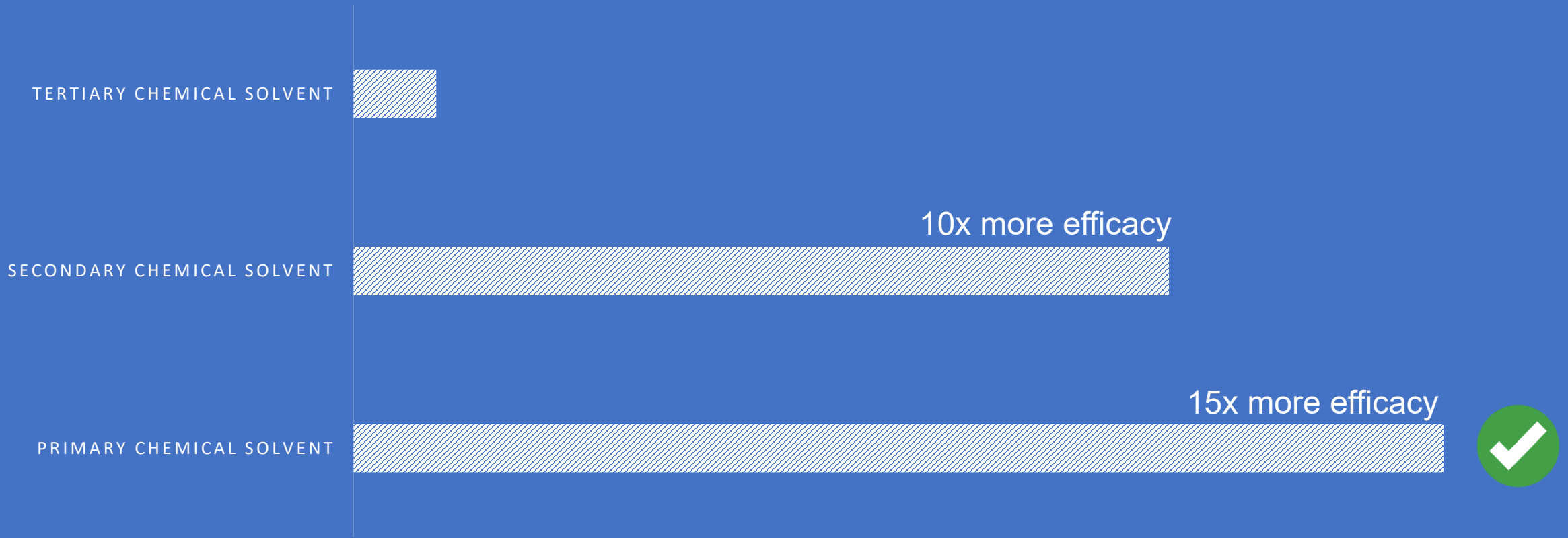


Simulation Study

Pressure Comparisons



CO2 RECOVERY AT ATM PRESSURES (PCC STREAM)



Simulation Study

Energy Comparisons



SPECIFIC REBOILER DUTY (GJ/TONNE) FOR 95%+ CO₂ RECOVERY

BASELINE PRIMARY SOLVENT



~15-20% lower energy requirements

STERICALLY HINDERED PRIMARY SOLVENT



Key Considerations

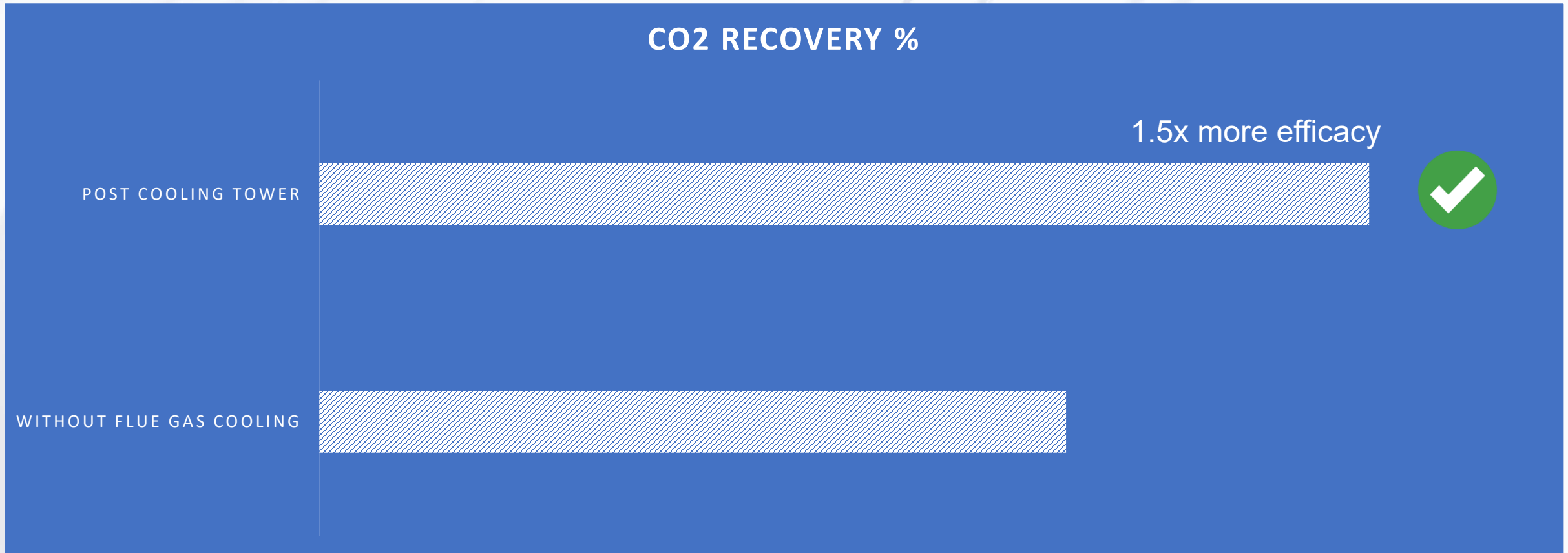
What are some other design aspects to consider in CC?



Other Key Aspects	Problems	Suggestions to Tackle
Temperature of Feed	If the flue gas is not cooled, the CO ₂ kinetics (exothermic in nature) will be hampered	Direct contact cooling tower before CC
Contaminants in Feed	SO ₂ , NO ₂ , O ₂ can degrade the amines	Caustic/alkaline sorbent dosing in the cooling tower Use of sterically hindered amines (good resistance to oxidative degradation) and/or addition of amino salts to the solvent (good resistance to oxidative degradation)
Contactors Internals	At low pressure carbon capture, a higher efficiency mass transfer is required to capture CO ₂	Packings (preferably structured) over trays
High CO₂ Compositions	CO ₂ at high concentrations in streams that are predominantly aqueous or vaporizing water can lead to corrosion (e.g. reboiler)	Appropriate MoC selection (SS) Sufficient reboiler duty to strip CO ₂ from the used solvent
Solvent OPEX	Loss of solvents into vapor phase due to low pressure applications can lead to large makeup rates	Application of water wash system

Key Considerations

Flue Gas Feed Temperature



Key Considerations

Flue Gas Contaminants (SOx)



HEAT STABLE SULFITES IN AMINE SOLUTION (PPM)

WITH PRETREATMENT



WITHOUT PRETREATMENT

500x more HSS in system

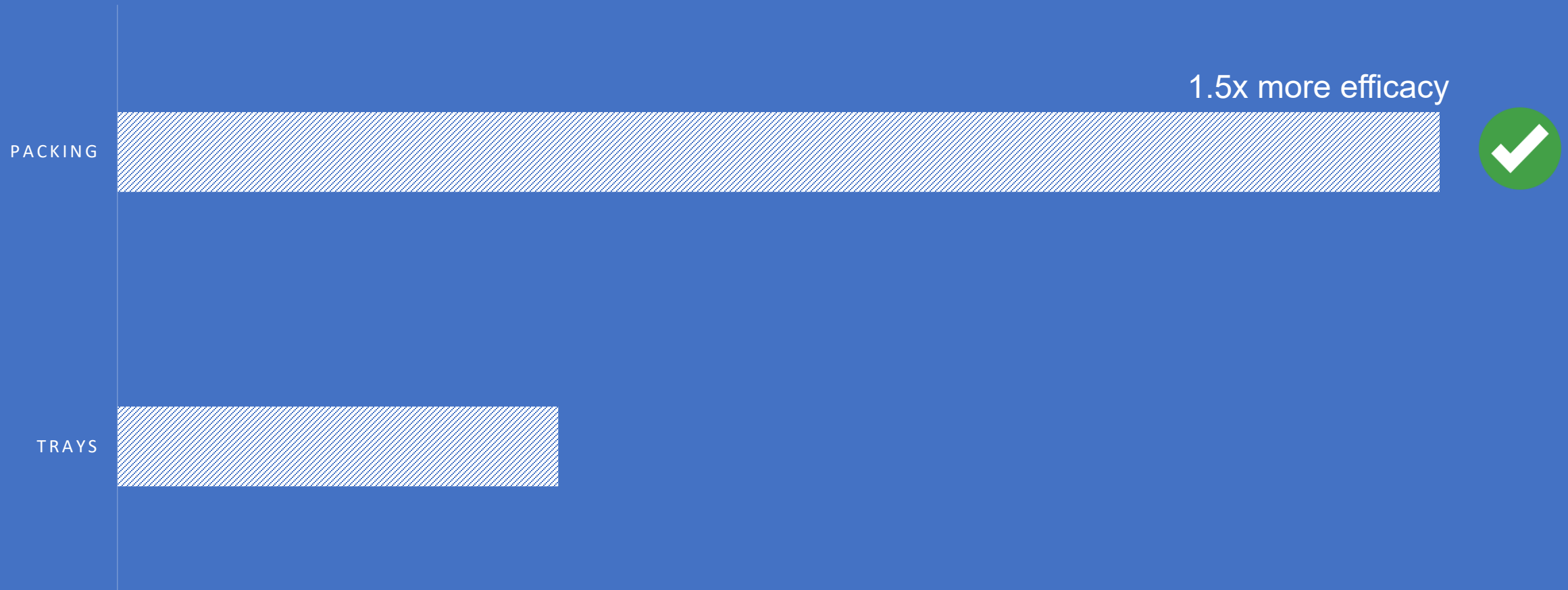
And continues to build over time...

Key Considerations

Contactors Internals



CO2 RECOVERY %



Key Considerations

High CO2 Streams

CO2 MOL% IN REBOILER (FOR 90%+ CO2 RECOVERY)



Key Considerations

Solvent OPEX

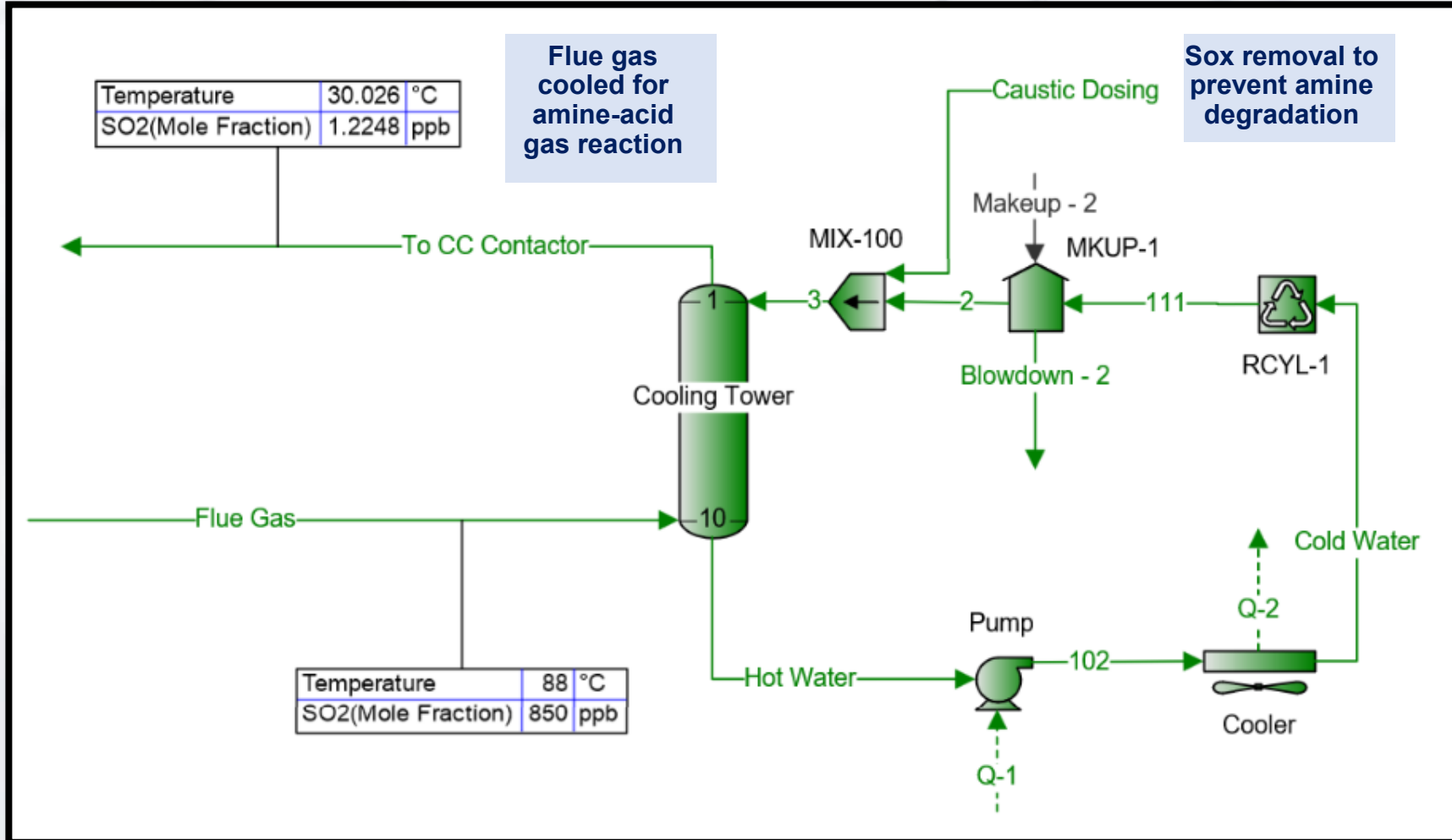


SOLVENT LOSSES AS % OF RATED FLOW



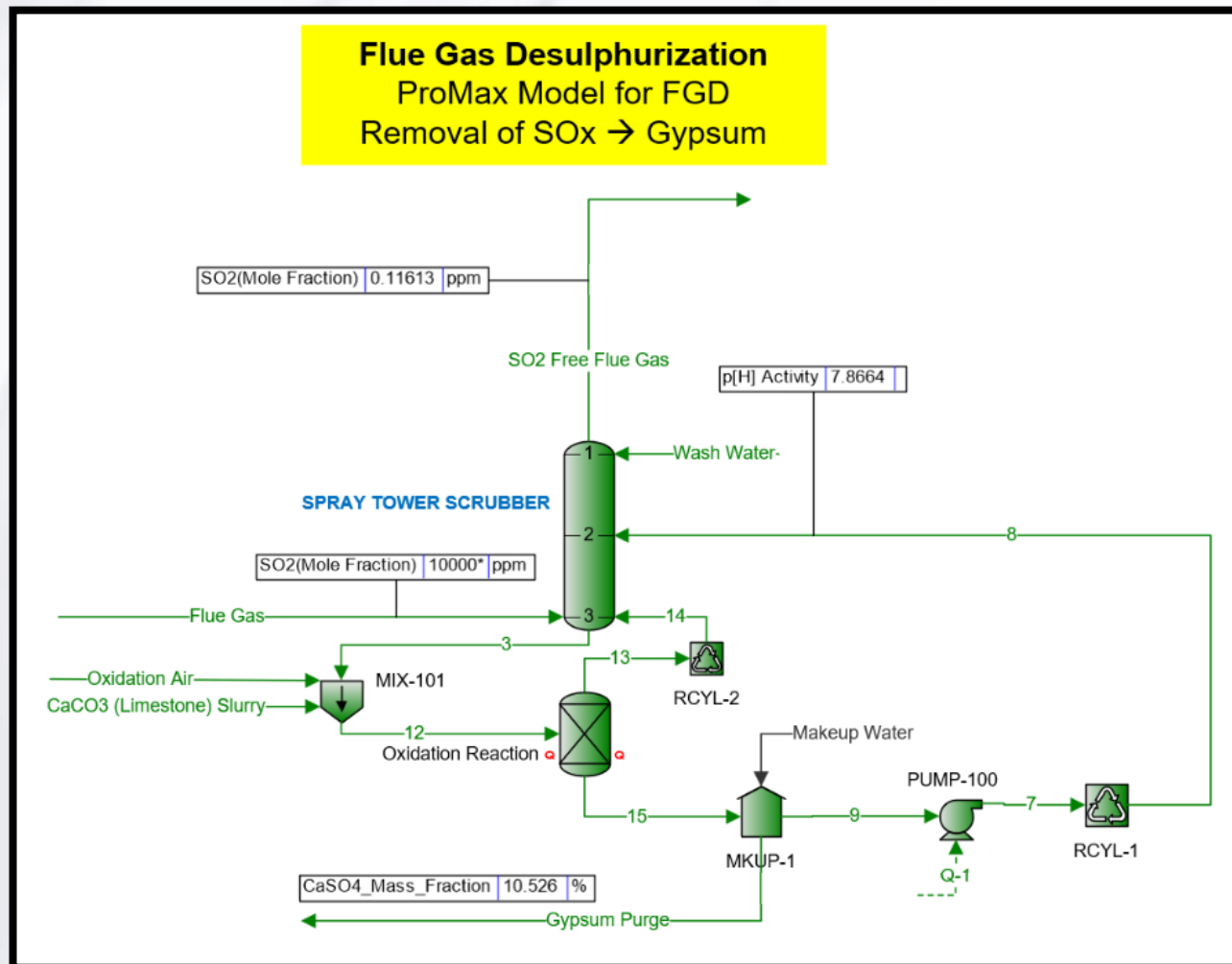
Final Process Scheme

Section 1 – Pretreatment (SOx Removal & Cooling)



Final Process Scheme

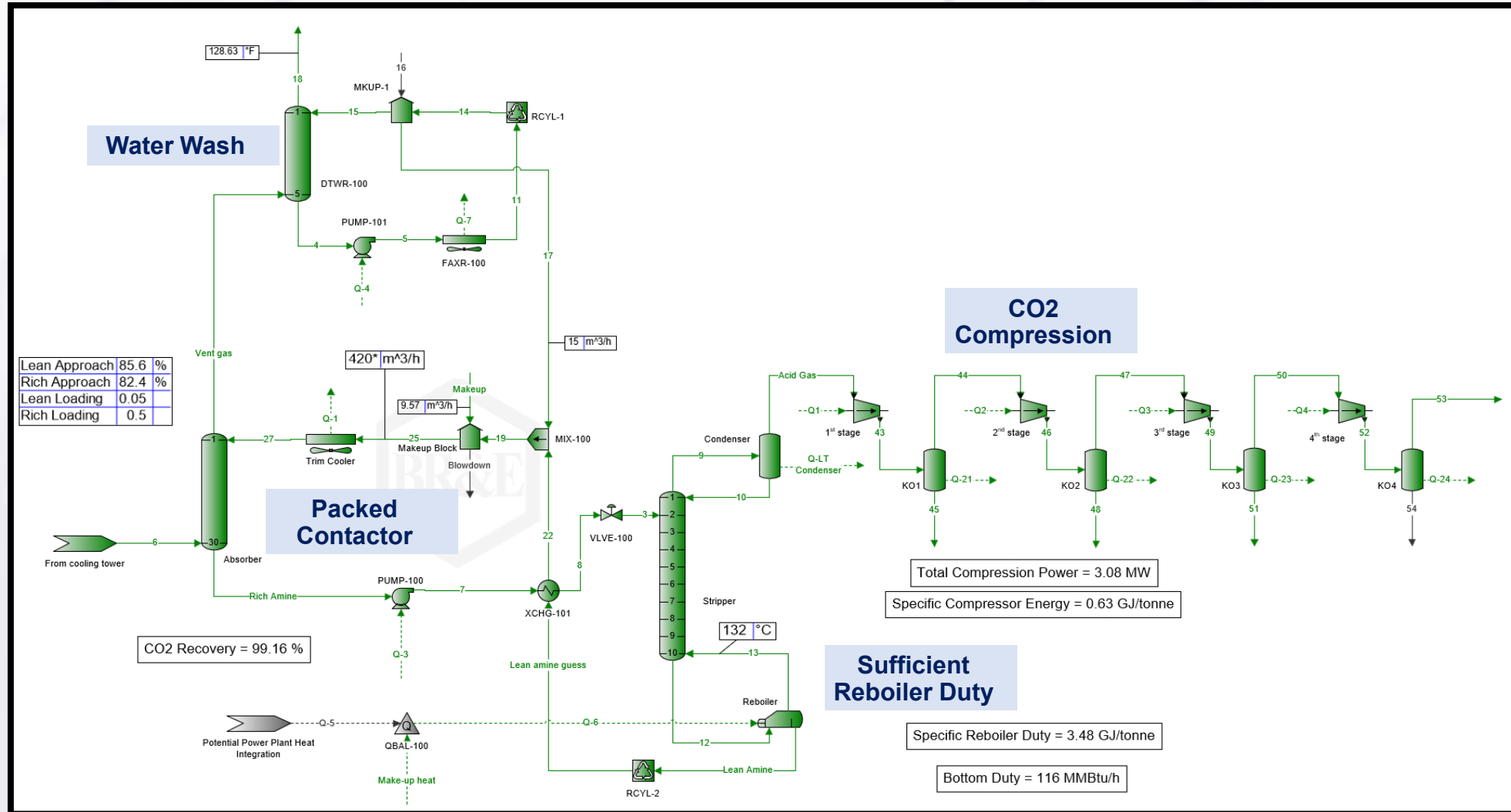
Section 1 – Pretreatment (SOx Removal & Cooling)



- Another method to remove SO_x is via an alkaline-based slurry - usually a mixture of limestone + water.
- The SO_x gases are subsequently neutralized and the slurry produces CaSO₃ which in-turn can be oxidized to CaSO₄ (aka Gypsum or FGDG).
- This is a **cost benefit** to the process because gypsum is marketable and can be sold as a byproduct.

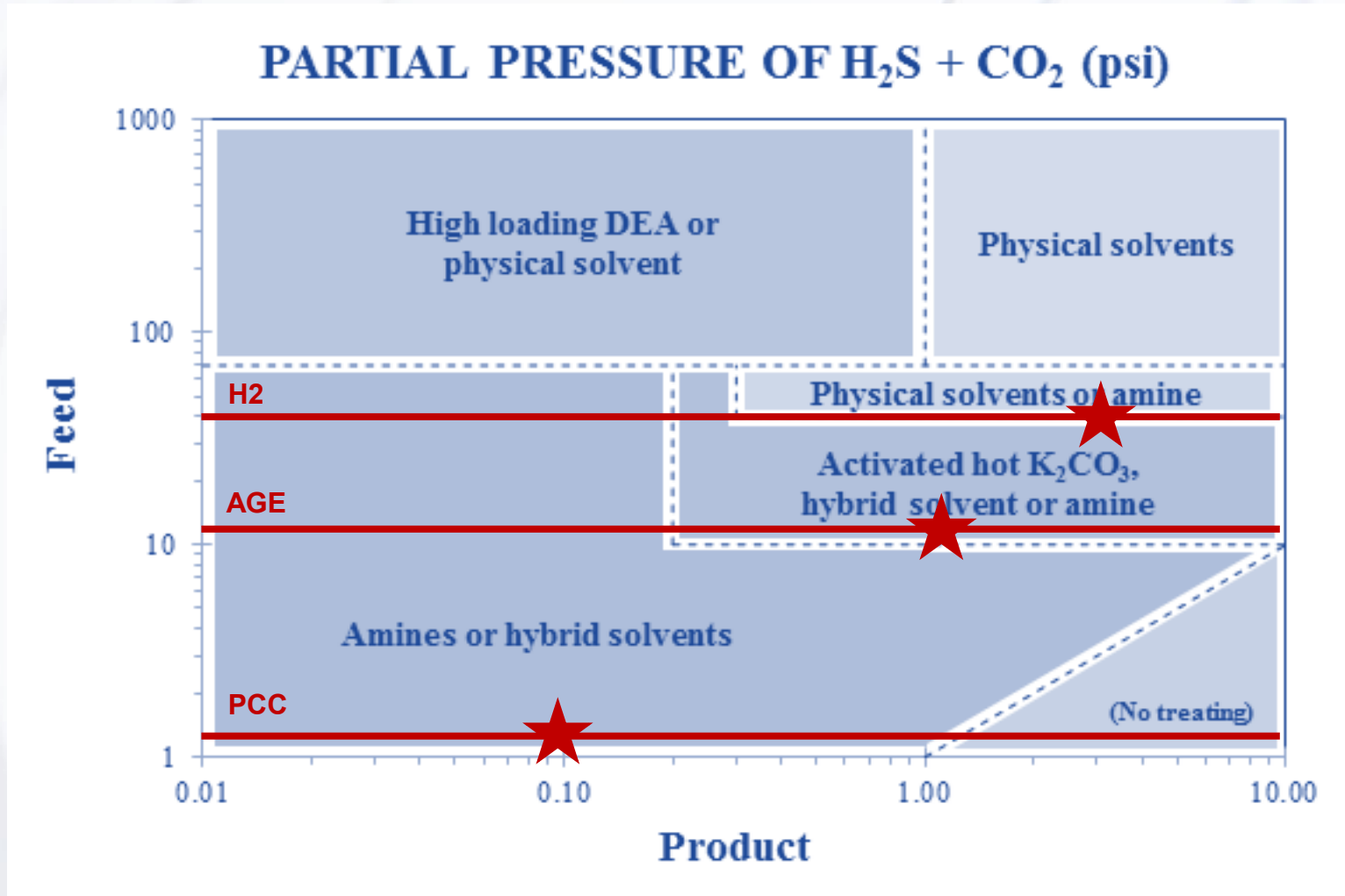
Final Process Scheme

Section 2 – Carbon Capture Unit



Conclusions

Technology Mapping



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Thank you, I am open for questions now!

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