METHANE TO AROMATICS

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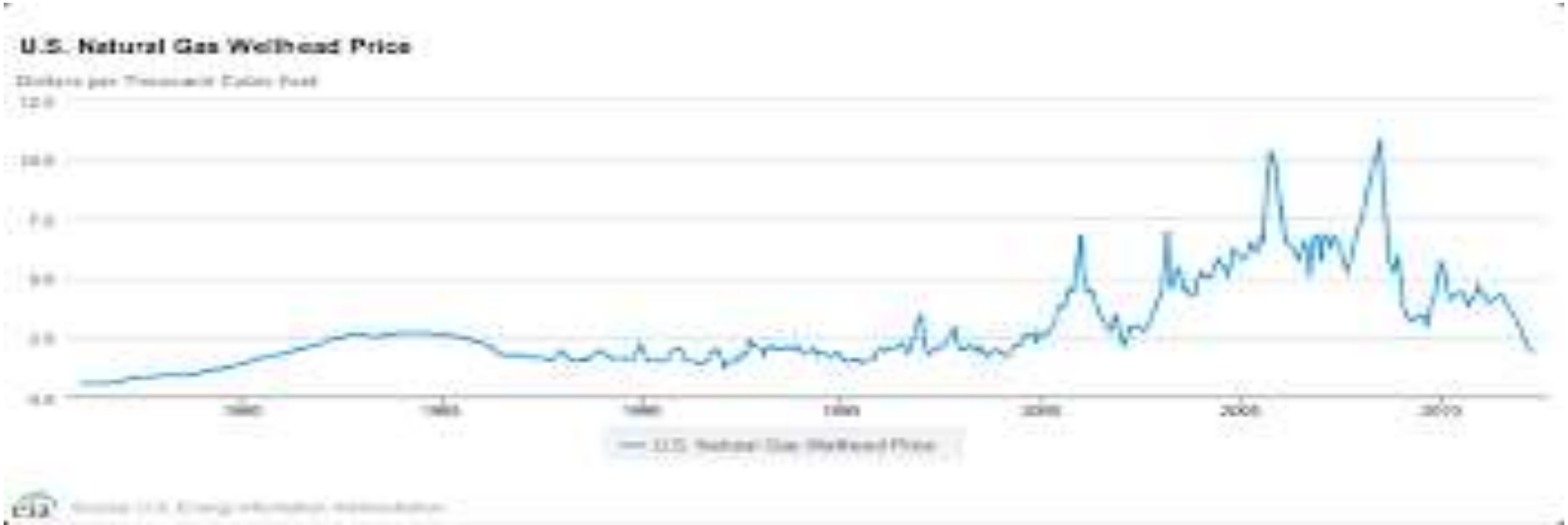
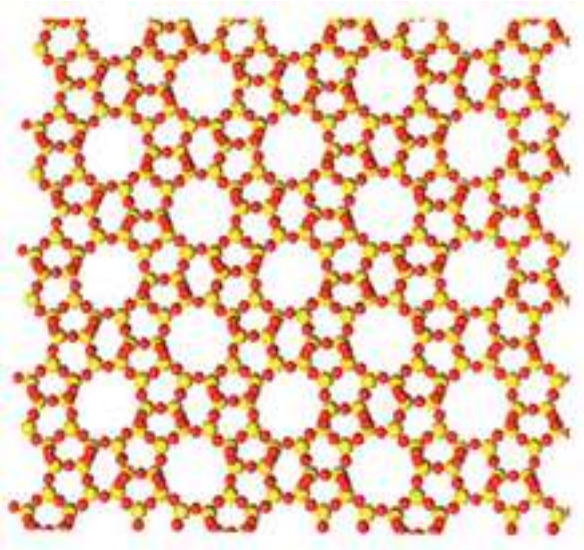
Background

- Current glut (valley) in natural gas prices
- High BTX product demand
- North America currently imports benzene to meet demand
- This enables a sizable opportunity for processes that convert natural gas to benzene that has no sign of becoming smaller

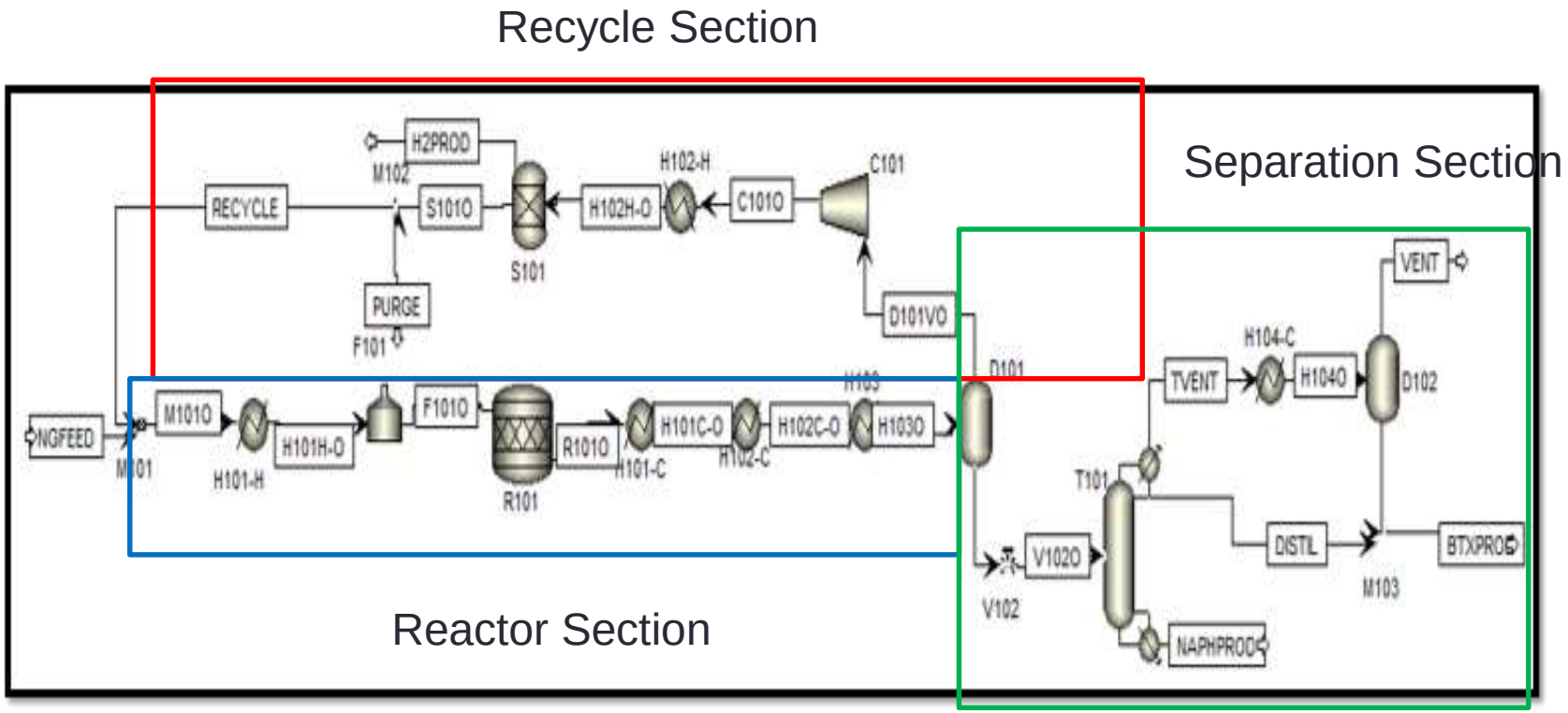


Process Overview and Issues

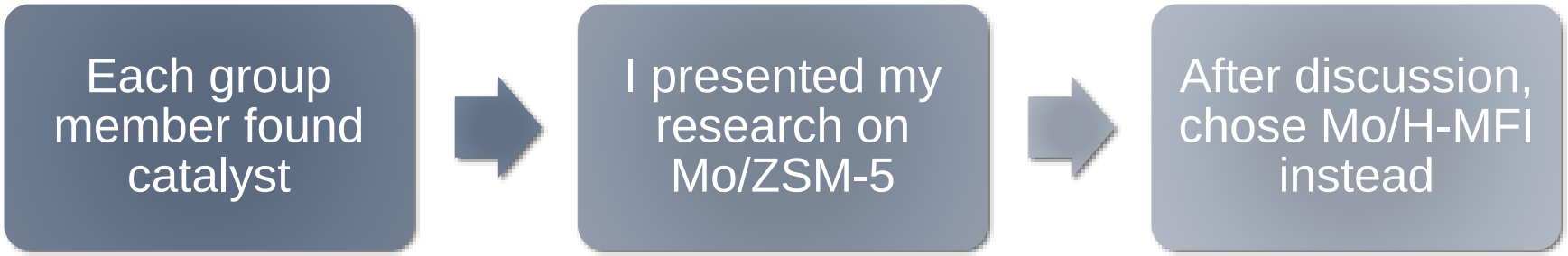
- Use natural gas as the feedstock to produce 728 million lb/yr of mixed benzene and toluene
- Molybdenum catalyst facilitates reaction
  - Can become deactivated due to coking
- Various byproducts as result of reaction
  - Hydrogen and Naphthalene



Process Flow Diagram



Catalyst Research

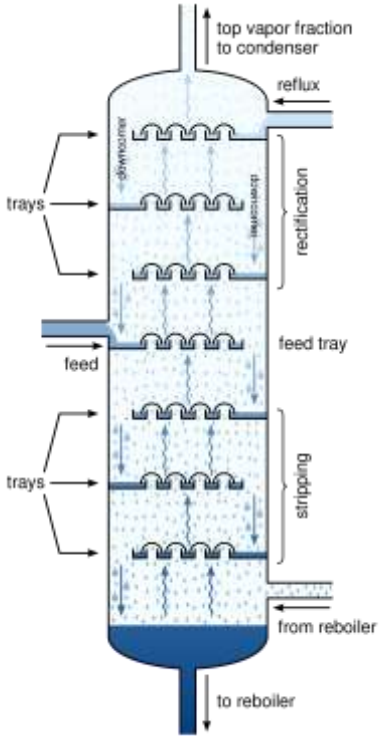


Constraints

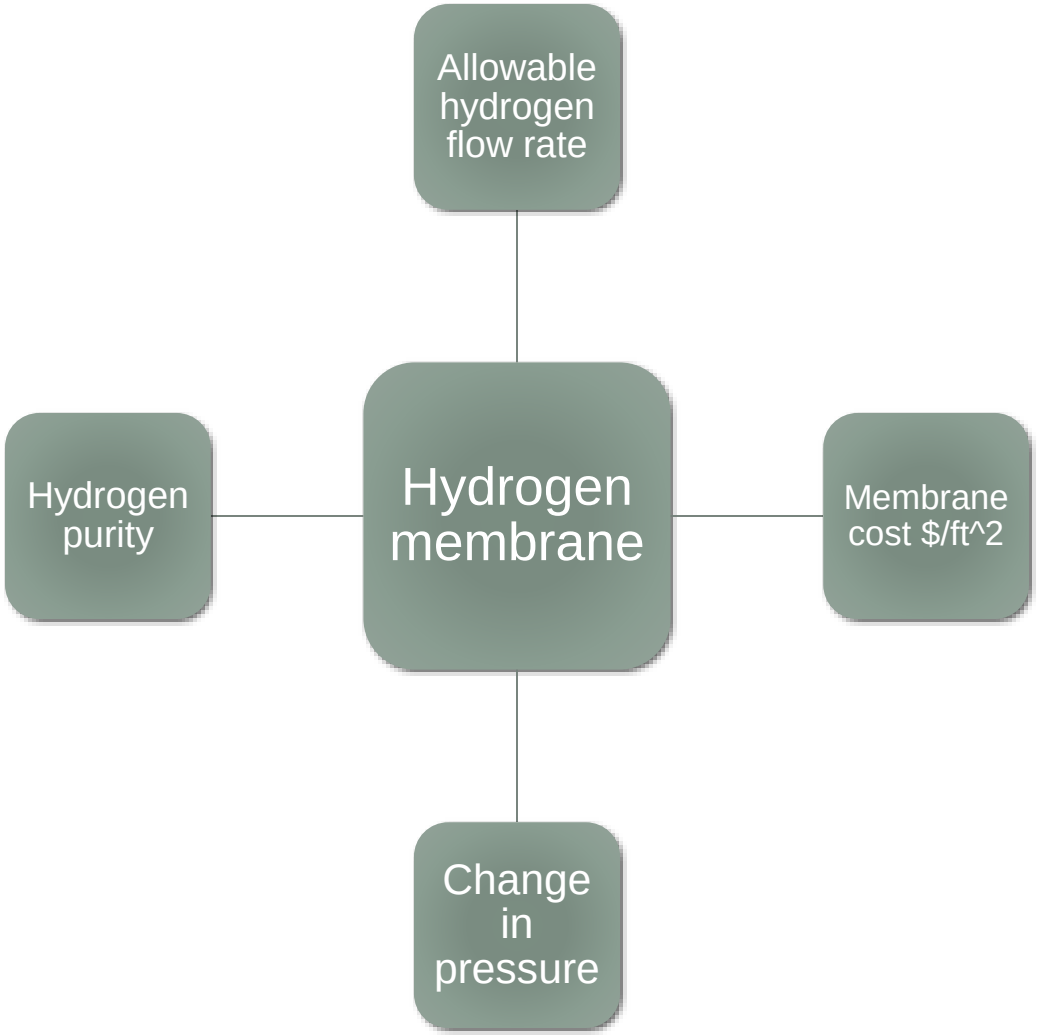
Constraint	Type of constraint	Constraint met (Y/N)	How? (Design value)
Air Pollution	Environmental	Y	Apply for permit
Energy Consumption (depletion of natural resource NG)	Environmental	Y	Brief analysis of NG market
Cost of chemicals	Economic	Y	Economic sensitivities
Feedstock limited by amount that is produced	Product/Feedstock	Y	Comparing our use to total production
Unit Op Material Compatibility with chemicals	Safety	Y	Use stainless steel for unit ops

Design Layout and Optimization

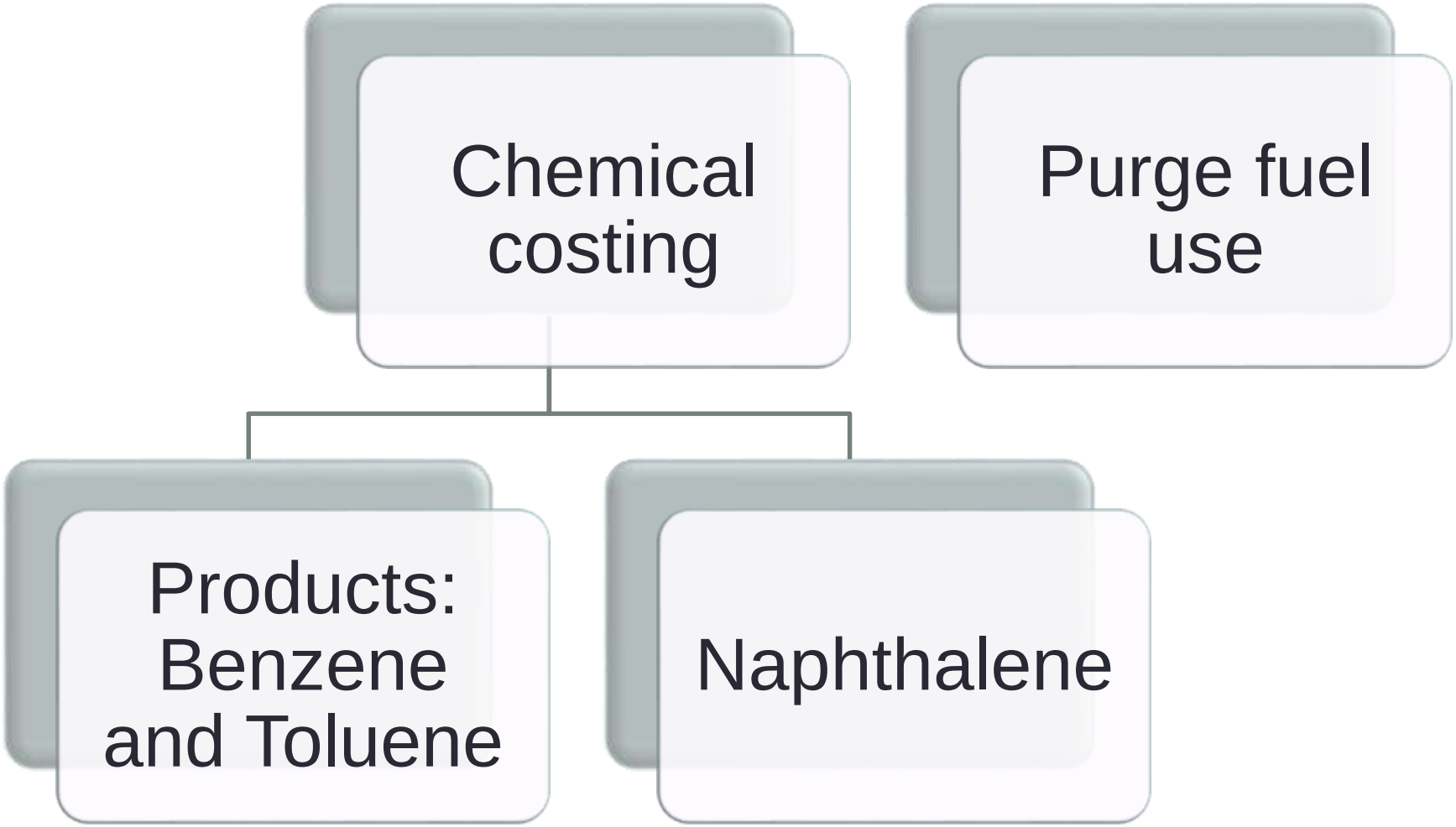
- Used Visio to create initial process flow diagram
- Later helped rest of group in making initial Aspen model, converging it
- Optimization of distillation tower



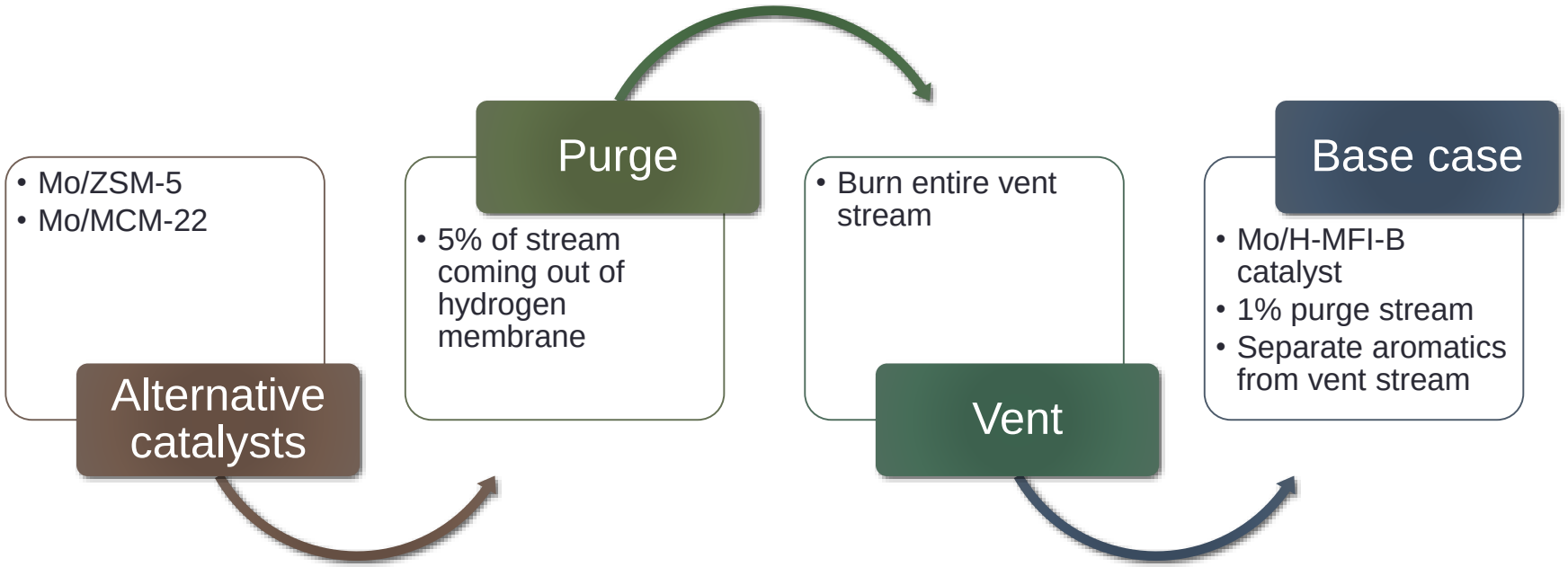
Unit Operations Sizing and Pricing



Economic analysis



Design Alternatives



Safety and Risk Management

Heat Exchangers

- Safety issues
  - Large Temperature deviations from norm
- Risks Management: Adjusting cold or hot stream flow

Reactor

- Safety issues
  - Temperature and Pressure deviations
  - HTFA
- Risk Management: Use stainless steel, lower/raise heating/cooling and feed streams,

Distillation tower

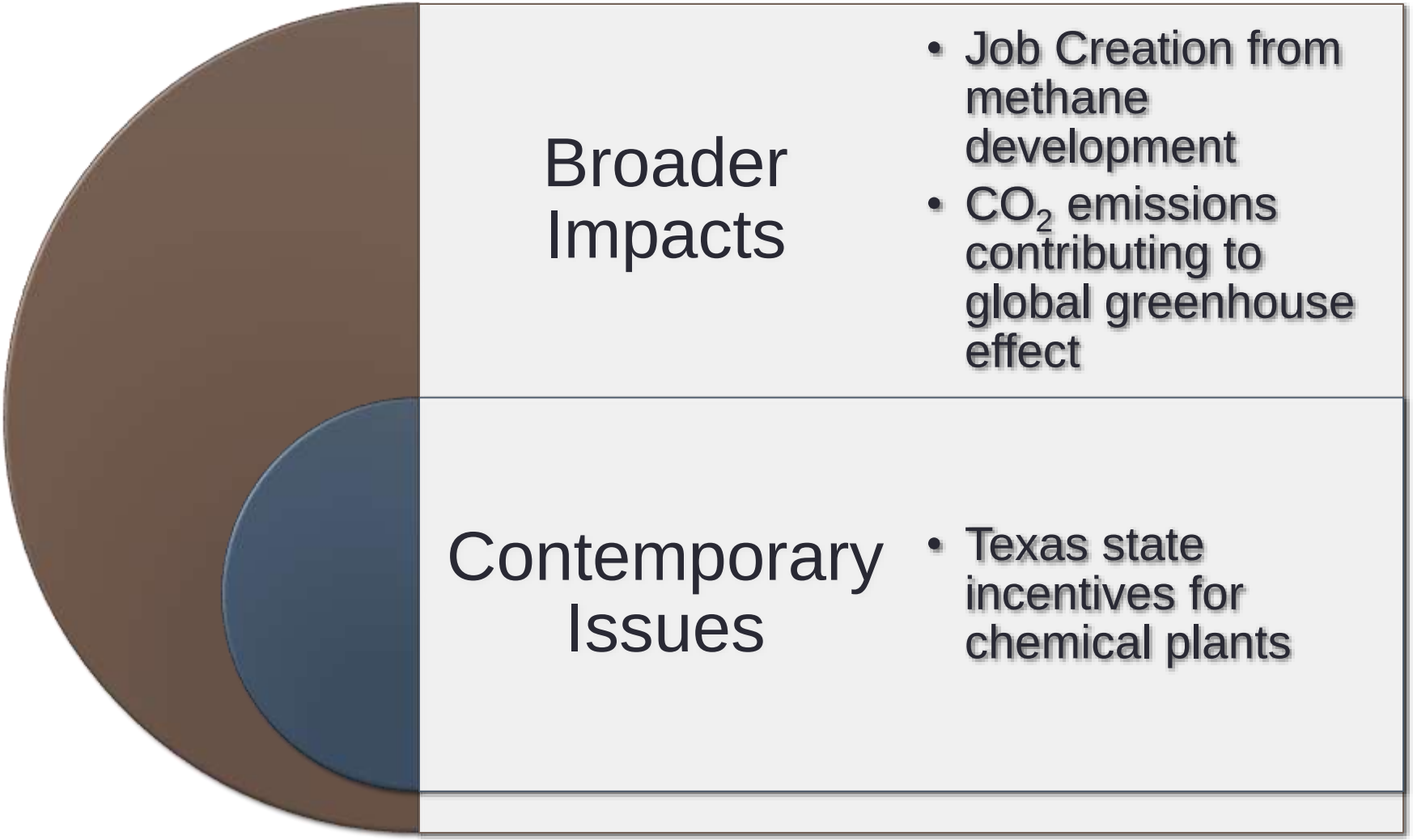
- Safety issues
  - Leaks
  - Obstruction of feed stream
- Risk Management: Install level alarm and feed flow-rate meter

HAZOP Analysis Table

- Helpful tool in analyzing the risks with each unit op, along with how to make them safer
- Example:

Unit Op	Guideword	Deviation	Causes	Consequences	Action required
Distillation tower	Utility failure	Failure	Power to reboiler stopped	Insufficient reheating resulting in impure bottoms product	Install temp. sensor

Broader Impacts / Contemporary Issues



Questions?